Winter 1986

NAVY CIVIL Engineer

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Story on page 16

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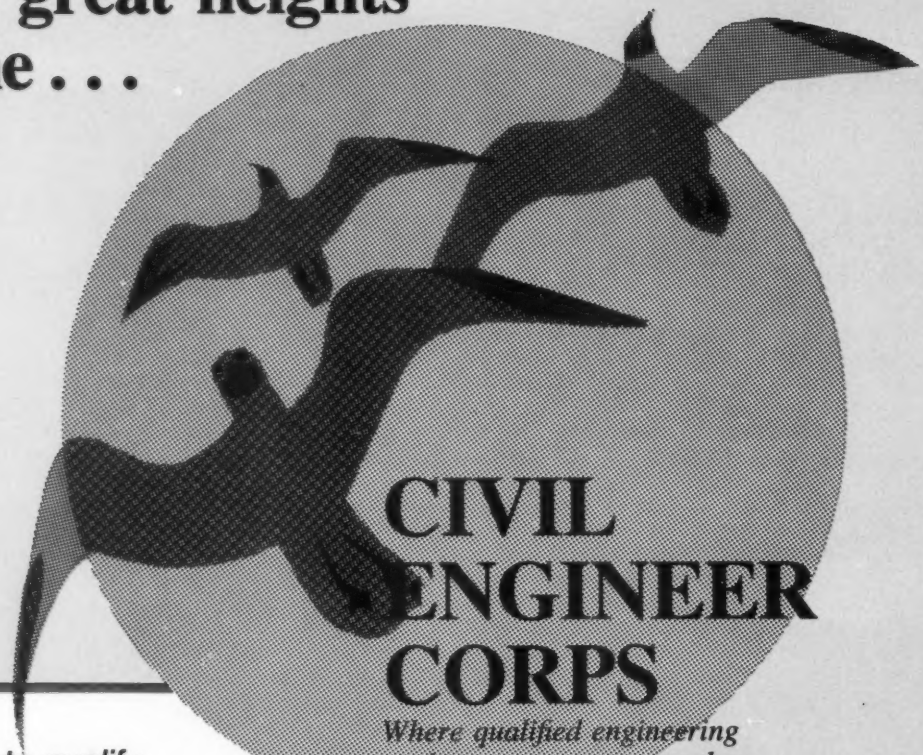

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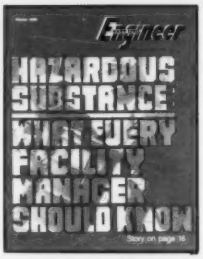

THE COVER

The two "actors" seen through the window/letters on the cover are wearing special suits for protection in a mock-up emergency for handling hazardous substances. The suits provide the highest level of respiratory, skin, eye and mucous membrane protection to the wearers. The story begins on page 16. Cover art by Joy Ardalan.

NAVY CIVIL Engineer

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Fresh water supply system developed on Diego Garcia

By STEPHEN W. SURFACE
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The remote island of Diego Garcia provides vital support to our missions in the Indian Ocean and Middle East. Population on the island is currently from 5,000 to 7,000 personnel with an average daily potable water demand of approximately 3,000 m³/D (0.80 mgd). This is expected to increase to nearly 4,700 m³/D (1.25 mgd) when all facilities are in place.

Development of a potable water supply has evolved since the beginning of construction in 1971 from desalination as a source, to brackish water, and finally resulting in development of fresh ground water consisting of over 100 shallow wells providing a reliable, cost effective, and operationally simple fresh water supply system.

The sustainable quantity of fresh ground water available was not expected for a small, narrow atoll and the method which was developed jointly with the U.S. Geological Survey (USGS, Honolulu District) is being used to ensure a continued fresh supply.

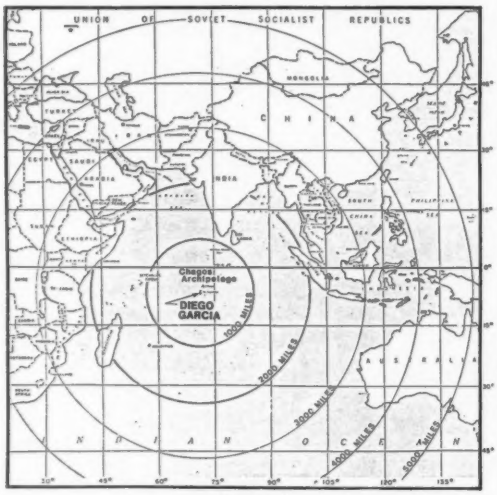


Figure 1

Background

The island of Diego Garcia lies approximately 72°25′ East Longitude and 7°15′ South Latitude, one of the most isolated spots in the Indian Ocean (Figure 1). It is a classic coral atoll stretching in a misshapen horseshoe configuration and is 61 km from one end to the other (on land) (Figure 2).

The 2,300 hectares of land are low lying and the width of the land varies from a maximum of about a mile and one-half at its northwestern point to only 30 to 45 m at the south end near the barachois and on the east side. The island is covered with vegetation varying from herbaceous grasses to Australian pine and coconut trees over 30 m high.

Diego Garcia is composed to an unknown depth below sea level of coral and coral derivatives. The only noncoral rocks found on the island are waterworn fragments of pumice (probably from the explosion of Krakatoa in 1883).

The average tidal range is about 2 m. Prevailing winds average about 11 knots and are from the southeast occurring April through September, and northwesterly during December and March.

Diego Garcia is blessed with a fair amount of rainfall with fairly uniform distribution throughout the year. This rainfall makes for the lush tropical growth found on the island. Rainfall records have been kept since 1951 and the average over this 33+-year period is 2,580 mm (101.6 inches). The monthly average varies from a low 151 mm (5.94 inches) for June to a high 320 mm (12.58 inches) in January. Table 1 presents recent rainfall data.

During the past 200 years, French and British colonists formed plantations utilizing the numerous coconut trees growing on the island. The coconut oil and, eventually, copra by-products were marketed through ships passing between trade centers in Madagascar and Indonesia.

The United States and Great Britain signed a bilateral agreement in 1966 with a supplement agreement in 1972 which allowed construction of a communications outpost on the western half of the island. Seabee

construction began with the landing of NMCB 40 advance party in March 1971, and in October 1971, the last of the plantations were closed.

Development of the Water Supply

The first water supply used by Seabees upon arrival in 1971 was wells located in the Cantonment area which were dug to about 1.5 to 3.0 m deep. Subsequently, desalination barges were brought from Vietnam and were anchored in the lagoon. The system utilized distilled water for potable use and salt water pumped from the lagoon for head and shower use.

Design for a distillation system, in the early 1970's, was for a population of approximately 550 personnel located over five widely separated areas. However, the problem of constructing an integrated distribution system connecting these areas was overwhelming. Because of this setback, and also the time frame was accelerated, limited planning began for an alternate system using ground water.

The first ground water exploration for a permanent supply system was accomplished in 1973 in the Cantonment area using a 10.5 m well with a 560 mm diameter slotted casing. The static water table was at elevation to + .45 m (approximately) and about 2 m below ground surface. The water exhibited good quality as shown in Table 2.

The quality exhibited was excellent in terms of freshness (chlorides) and drinking water standards (even the total dissolved solids [TDS] was good). Only hardness was high, but this was indicative of a ground water contained in a coral media.

Lacking time and funds to do an adequate hydrogeological study, including a drilling program, a very limited study was made. Because of the sandy soil-coral condition and limited land area, the amount of fresh ground water was thought to be limited and would deteriorate to a brackish quality with pumping.

The decision was made to use a desalination process that would handle a brackish water supply. Options were limited to either reverse osmosis (RO) or electrodialysis (ED), and ED was selected and required power was available.

ED units had been used very successfully at an existing Navy installation at Northwest Cape in Australia since 1965. Installation of ED units at five separate sites was completed in early 1978.

Sixteen wells (approximately 4 to 9.1 m deep) were installed by 1976 as the permanent source for the ED units and used during the interim for the potable water supply utilizing only aeration (to remove H_2S) and chlorination for disinfection.

The quality remained very good (well within drinking water primary standards) during this entire period. The depth of these wells was based on the concept that greater pumping capacities (2.2 to 3.1 liters per second [1/s]) would result; although it was thought that the water would become brackish with continued pumping, this was not considered to be a problem because the ED units would provide adequate treatment.

When the newly-installed ED water treatment units were placed in operation, they clogged badly, and therefore, their performance was unsatisfactory. Bacterial densities were measured to be about 10^4 to 10^5 organisms per ml Standard Plate Count (SPC) and resulted in complete clogging of the ED membranes within 72 hours of operation. →

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1978	22.90	5.47	8.79	3.26	5.71	3.15	5.40	2.06	2.61	3.65	1.84	9.21	74.05
1979	7.46	12.78	6.51	1.26	1.19	.59	2.24	2.79	17.45	8.63	3.28	10.41	74.59
1980	14.97	10.85	4.09	9.88	4.04	6.35	7.84	4.41	6.15	15.92	6.38	9.70	100.58
1981	14.44	9.81	6.55	15.29	3.71	7.40	5.99	2.39	15.96	7.23	10.25	13.76	112.78
1982	9.87	9.59	10.73	6.17	1.60	7.37	1.10	3.07	6.25	15.01	8.09	17.38	96.23
1983	17.56	15.55	7.90	11.99	12.75	4.80	3.91	.65	13.89	12.72	15.90	19.06	136.68
1984	14.27	12.72	3.80	18.27	6.08	2.12	2.56	3.51	1.30	9.54	7.64	12.34	94.97
1985	5.10												
											(Mean 1951-1984)		101.6

Table 1 — Monthly Rainfall

Parameter (units)	Value		
pH (units)	7.6	Turb. (NTU)	0.3
$C1^0$ (ppm)	73	NH_3 (as N, ppm)	0.011
Fe^{+3} (ppm)	0.05	Total Kjeldahl Nitrogen (TKN) (as N, ppm)	0.124
Mn^{+2} (ppm)	0.45		
H_2S (ppm)	0.3		
hardness (total, ppm)	241	P (ppm)	0.007
Alkalinity (MO, ppm)	242	Zn^{+2} (ppm)	0.02
$Si0_2$ (ppm)	10.9	Cu^{+2} (ppm)	0.02
Total Dissolved Solids (TDS) (ppm)	460	Na^+ (ppm)	83
		K^+ (ppm)	1.3
SO_4^{-2} (ppm)	21	Total Coliform (MFC)	74

Table 2 — Water Quality

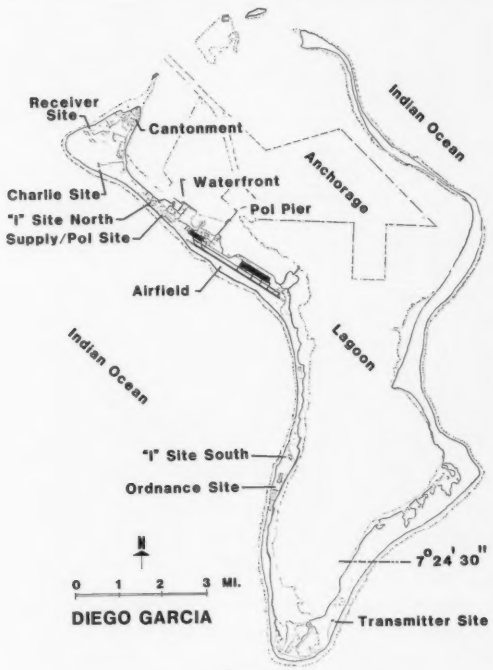


Figure 2

Shallow well water systems installed

Efforts to minimize clogging and/or bacteria entering the ED were unsuccessful even with the help of the manufacturer representatives. Additionally, some wells were lost due to saltwater intrusion (upconing) as a result of too high pumping rates.

Time was critical by now to come up with a satisfactory fresh water system. The projected population had increased to nearly 1,000 and the on-island population (including the construction forces) had long been over that figure.

With the primary assistance of the USGS, a field hydrogeologic study determined that the fresh ground water supply was adequate to meet the projected demands (approximately 1,135 m^3/D indicated during this time frame). Because of the lack of funds, the need for a quick determination, and the projected demand being lower than the estimated supply, no detailed and comprehensive testing and monitoring were made at that time.

The basis was that, although we did not know of the size and extent of the lenses, including depth, the projected demand was less than a very conservative estimate of the available sustainable yield.

The long communications and logistics lines to Diego Garcia and the Seabees' and operators'

capabilities were considered and as a result, the "shallow wells" water systems for Diego Garcia were recommended. This meant that we would install more shallow wells throughout the lens areas to skim off the fresh water at very low pumping rates that would not cause upconing.

Three shallow test wells were dug in November 1978 to determine the concept's workability and establish the pumping rate. The tests were successful and the pumping rates were established at 0.6 to 0.9 l/s (later set at 0.75 l/s).

With funds still in short supply and the expansion requirements of Diego Garcia still not identified, the proposal was made to RAdm. Iselin in May 1979, who authorized prototype wells (one horizontal well and one module containing five vertical wells) be installed and evaluated to determine which type of well was best.

The evaluation was cut short when the expansion requirements and increased water requirements for Diego Garcia evolved rapidly following the Iran hostage problem. Vertical wells were chosen over the horizontal wells because of constructability with limited Seabee equipment and resources, although horizontal wells were considered more efficient. Other factors, including fill, jungle growth, and swamps were considered.

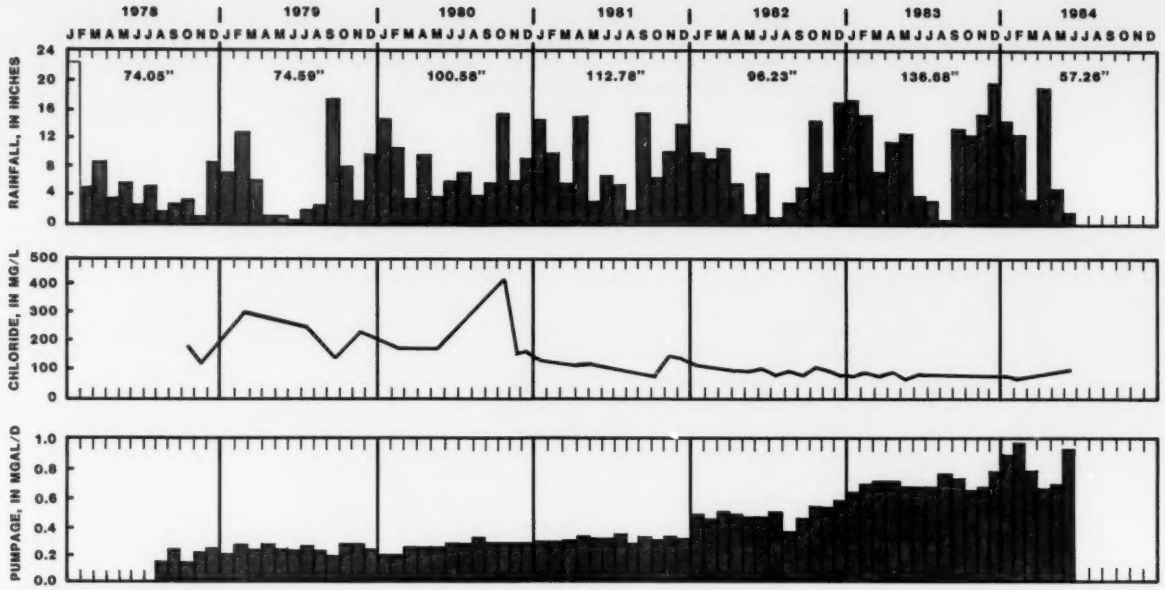
After completion of design, purchase and shipment of materials, vertical wells were installed by NMCB 133 in May to June 1980 with the assistance of PACDIV/USGS (Figure 3).

Of foremost importance is that we needed a system that was very simple, reliable and cheap! The fresh ground water lens was the cheapest source of water on Diego Garcia. It was also simple to obtain and treat (a small centrifugal pump and chlorination). But its supply was exhaustable and could be contaminated by saltwater intrusion by excessive pumping rates and over withdrawal.

Alternate sources using such methods as rain catchment and desalination were significantly more expensive and less feasible. Therefore, careful management of the pumping rates of the existing and proposed wells was a must. Interim operating instructions for the reduction of pumping rates and management of the system were developed.

A significant improvement in the operation and maintenance of the existing water system and maintaining low pumping rates were reported in January 1981. It is felt that a very satisfactory level of operation has been maintained since that time. This can be seen by the trends in the level of pumping and chloride content (Figure 4).

Additional projected demands were again planned for the island. A surge was anticipated in the latter half of 1981 as a result of the introduction of a construction contractor and other increasing island activities. Thus, simultaneously, wells were added in the Cantonment area to result in a pumping capacity of 1,900 m^3/D (pump rate and quantity established by USGS) and a water resources expansion study was begun to determine what the lenses' sustainable limit


1978
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RAINFALL, IN INCHES
74.05"
74.59"
100.58"
112.76"
96.23"
136.68"
57.26"
CHLORIDE, IN MG/L
PUMPAGE, IN MGAL/D

Figure 4

were and whether they could support the new demands.

The study included the installation of over 75 monitoring holes (Figure 5) at various depths (often three different depths per hole) probing the lenses and resulting in the first estimate of the size of the major aquifers.

The holes were concentrated on the island's most important areas: the Cantonment, AirOps, Industrial site (I-site), and the Transmitter site (T-site). Simultaneously, other secondary sources were examined again, including RO for both salt and brackish water, ion exchangers, rain catchment, and distillation.

The study indicated that besides the major aquifers in the Cantonment and AirOps areas which were approximately 20 m thick, the I & T-sites exhibited aquifers which were similar but smaller. The analysis indicated that the estimated sustainable yield from all areas was very close to the design demand of 4,700 m^3/D, and therefore, the lenses must be monitored and managed to ensure maximum efficient withdrawal on a sustainable basis.

The lenses were found to be somewhat unique in that a sharp boundary in water quality was formed by a thin limestone layer which was found at the base of the fresh water.

Conductivities changed dramatically from about 1,400 $\mu S/cm$ to greater than 25,000 $\mu S/cm$ inside the limestone, and 50,000 $\mu S/cm$ (seawater) after penetration of the limestone layer (a distance of approximately 2 to 4 m).

Additionally, tidal efficiencies were found to vary from 10 to 100% with an average of nearly 75%, which indicated the sensitivity and fragile nature of the lenses.

Design and construction have proceeded on the basis that the total supply would be from fresh ground water. To ensure that saltwater intrusion would not

With limited equipment and no shoring material, Seabees used clam shell and dug deeper holes which allowed for very slow velocities to the well casings.

Using the clam shell to place gravel pack, segregation of gravel pack is not a problem.

Covering the "filter cloth" laid over the gravel pack to prevent lines from dropping through the gravel pack.

Monthly sampling and analysis begun

occur because of overpumping of wells, exhaustive water quality tests have been done over the developmental years of approximately 1978-1984.

It is estimated that over 400,000 physical measurements and chemical tests have been accomplished. This data has been vital to our understanding of the extent and behaviors of the aquifers.

The present system consists of approximately 100 wells pumping 3,000 to 3,800 m^3/D. The water quality has remained essentially unchanged from that found in 1973 (Table 2). To ensure a safe water supply, a long-term water management program was initiated two years ago. This program consists of monthly sampling and analysis from a set of approximately 35 monitoring sites (or about 100 individual holes) and USGS review of the aquifers' condition.

The major aquifers in Cantonment and AirOps have been found to vary seasonally in storage as much as 40%. Other program benefits have specified uniform areal withdrawal and have indicated new wells can be located closer to the shore.

The program has also resulted in simplifying (reducing) daily operations for quality monitoring. The overall system is now reliable, cost-effective, and simple in operation.

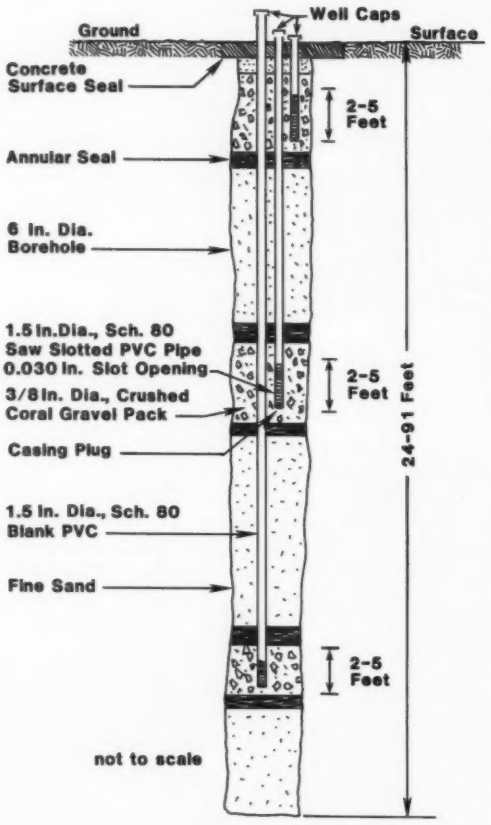


Figure 5

Typical beach in the lagoon area.

This supply, like most other water supplies, has not escaped the problems of pollution and contamination. Considering the limited land mass available, large areas had to be excluded for well sites because of sewage ponds, fuel contamination, sanitary landfill, mission requirements, and salt-fresh water interfacing.

In addition, pesticide contamination (previously applied and now prohibited) has to be removed from wells in certain areas.

Future Requirements

The projected future demand is anticipated to be 4,700 m^3/D with daily peak demands of 8,500 m^3/D, which can be met utilizing available ground water. The planned water improvements include additional horizontal wells in the AirOps area to allow for more uniform, areal withdrawal, increases in storage, and centralization for monitoring pumping operations (telemetry).

Active programs are also ongoing to ensure the water supply is free of harmful contaminants, water use is conserved, and leaks can be more easily detected. Present/future design of facilities allow for retention of rainfall runoff back into the aquifers. With the continuation of the long-term management program, the island's water supply should last forever! □

The authors wish to acknowledge Messrs. Daniel Davis and Charles Hunt of the U.S. Geological Survey, Honolulu, Dr. D.B. Chan, NCEL, and Messrs. Thomas Arita and Kenneth Imada of the Design Division, PACDIV for their efforts and support in the design of the ground water system on Diego Garcia. And to the individuals of the Seabee family for the construction of the facilities up to 1983.

Also, to Mr. Peter Abergas, DOICC Diego Garcia, who provided much island support on his own efforts for the comforts of the authors on numerous occasions.

Our commissions and accountability

It usually happens first when we're young. There's a moment, easily remembered, when one is first personally responsible for something and personally accountable for its outcome. It was perhaps in the family — an important chore; or in the classroom — that essay (!); or maybe as a member of a sports team on the playing field.

Whether it went well or not, the responsibility and accountability remained with that young person, usually in a very public way. Maybe the first experience tells the tale. If a success, it encourages another try; another success, another try and so on. The taste of accountability — particularly successful accountability — is a worthwile addiction encouraged by our friends and associates. Enough personal successes and one makes the varsity, makes the honor roll, graduates from college, and for some, receives a commission.

Take a look at your commission. It vests each of us personally with a special trust and confidence to be responsible and accountable for our actions now, just as we were when we first discovered what that means. We're not commissioned to fill out boards, committees, and

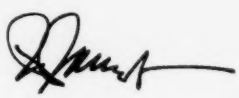
panels. We're not commissioned to surrender our thinking to the consensus. We're not commissioned to lubricate and operate a bureaucracy of systems. Instead, we are commissioned to do our own thinking, to draw our own conclusions, and to act with a sense of individual responsibility and accountability.

Because of the size of the Navy and the nature of the facilities business, officers of the Corps taste accountability throughout their careers. From a single contract to hundreds of them, from a single subordinate to thousands of them, from a single facility to all the facilities, our officers are involved in business decisions of some kind at every moment.

We are commissioned to make those business decisions with the highest sense of personal responsibility and accountability. In business decisions, cost is always an object; there is no such thing as response regardless of cost.

No where is this sense of personal responsibility and accountability more focused than on those officers privileged to serve in command. Our officers in command willingly and with full prior knowledge agree to this broadened personal charge by accepting command. Bucks screech to a halt in front of them from all directions.

Because of the inherent talent in the Corps — a talent honed in the accumulated, individual successes of our officers in the classroom, on the playing field, and finally on active duty — I have every confidence in our abilities and our continued successes, no matter the challenge. But I am also realistic enough to expect and to be prepared for an occasional mistake. When a mistake occurs, we will correct it, of course. We will also accept responsibility for it, in a personal and accountable way. Our obligations to our country, to our Navy, and to each other demand no less.



J. P. Jones, Jr.
Rear Admiral, CEC,
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COMNAVFACENGCOM/
CHCIVENGRS

Another dawn for management

By M. C. KOBLOS
Command Programs Coordinator
NAVFACHQ

Society, in its collective wisdom, has decided to change. The evidence is apparent to all who view the writing between the lines and the meaning behind the words of current social discourse.

The change is not occurring in some cataclismic upheaval of social trauma, but rather in the manner of the slowly developing realization of day from the darkness of the night before. The sun has not yet risen, but the glow on the horizon is sufficient to discern the nature of what is to come.

The most significant manifestation of the change taking place and, perhaps, its underlying cause, is society's shifting attitude concerning guilt. It has had so much guilt heaped upon it during the last two decades that society can no longer be influenced by its sense.

Guilt for a besmirched environment; guilt for an undeclared war; guilt for ignoring the handicapped; guilt for the condition of Blacks, Hispanics, and other minorities; guilt for endangering species; guilt for driving our youth to drugs; guilt for treating criminals unfairly; guilt for the past; guilt for the present; yes, and even guilt for the future.

The seemingly constant cry of "It's your fault!" has finally lost its sting. An immunity has built up, to the point where accusation is more boring than stimulating, and people are just plain sick and tired of being held responsible for everything . . . and they want out.

The psychological reaction was predictable, and is now apparent. The acceptance of communal responsibility is being cast off, and is being replaced by an expectation, no, a demand, for individual accountability. Society is reaffirming what it has always known, and that is, that every member of a society is responsible for his own condition . . . and personally responsible for his own actions.

Social attention has swung from celebration of the victim to cheering for the victor, as evidenced by the public response to Star Wars, Rocky, Indiana Jones, and Rambo. The people's search for heroes, for self-confident strength in nations as well as persons, is reflected in the acclaim for feisty Israel in the raid on Entebbe, and for American action in Grenada.

The nation's youth have turned away from the fashions of the agrarian poor, and now pursue the preppy look of well-dressed affluence. Cowering conformity has given way to prideful emulation, and whining protest to energetic advocacy.

The secondary impetus for change came about from the realization of a simple fact of economics . . . the greater the number of people involved in the furtherance of any enterprise, the greater the cost will be. Universal involvement in societal affairs over the last two and a half decades by individuals, committees, coalitions, lobbies, pressure groups, unions, church organizations, etc., has virtually bankrupted it.

The heavy cost of involvement and participation threw our national productivity into a nose dive, and has shaken the very foundations of public and private institutions (e.g., New York City and the Chrysler Corporation). The realities of the times can no longer afford the cost of allowing everybody to get into the act.

Whether we like it or not, a new era of self-reliance and individual responsibility is dawning.

What does all this bode for "management"? Change, of course. Management concepts and philosophies are natural developments of the times, rather than creations to fill a need. Management is not a trailblazer. It is basically a great compromiser.

As long as production or achievement can continue, management will submit itself to almost any kind of philosophical or structural configuration necessary to actually, or apparently, maintain its compatibility with the social condition prevailing at the time. In short, at any point in history, management is the way it is because society is the way it is. It has to be, in order to survive.

The question before us now is how changes in management practices will manifest themselves in the light of the current social transition. The answer to that question is of importance because any organization, or enterprise, that can identify the changes that are to come in the management arena will be better prepared to cope with, and adjust to, the circumstances that will pertain.

We have seen how society's acceptance of communal responsibilities, reflected by the concept that everything is everybody's business, was duplicated in corporate America with concepts of management by objectives (MBO), participative management, quality circles, management by committee, theory "Z," etc. . . .

As the pendulum of societal change swings to the right, management too will swing away from "group"

to "individual" focus. Some examples of how this alteration in focus may be expected to be demonstrated are:

- Group, or shared, responsibility will give way to disciplined individual accountability.
- Objectives developed by the achieving group itself will be supplanted by directed actions and directed levels of performance from an accountable executive.
- Efforts to motivate voluntary cooperation will be replaced by expected responsiveness to directed actions.
- Rights and benefits bestowed upon a group by virtue of longevity will be overshadowed by those earned on the basis of individual performance.
- Personal executive staffs will be obviated by "hands on" line supervision.
- Training programs will no longer focus on employee development, but rather on that training necessary to enable an employee to satisfactorily do the work he is paid to do. Training will focus on enhancing employee performance rather than employee potential.
- Organization charts will look less like completed games of scrabble and more like short triangles with wide baselines.
- Employee problems born and nurtured outside the work place will not be treated during working hours. Problem employees will be simply let go.

There are eddys of sentiment against the societal change underway, but the tidal current has changed its course and, while it can be impeded it cannot be stopped. Management practices will be carried along with it as has historically been the case. □

comments/questions

McLaughlin praises 'flag' editorial & author/ex-professor

Dear Ted,

I read your editorial — "The American Flag: Now and Forever" — in the recent issue of the *Navy Civil Engineer Magazine* and thought I would drop you a note to tell you how much I appreciate your thoughts and ideals.

All of a sudden I was sitting in class at CECOS and the year was 1958 — seems like only a few days ago. I wonder if you realize how much you have contributed to help so many young men to be "The best, the brightest, and worthiest." Your contribution to these young Americans and in turn the country, I am sure is a great source of satisfaction to you.

I am particularly encouraged to know that your influence is there. You have made and continue to make a gigantic contribution — thank you.

Capt. Edwin W. McLaughlin CEC, USN (Ret.)

Thank you Capt. McLaughlin for allowing us to print your letter to Professor Ted Murphy, and to Professor Murphy for forwarding the letter to us. The editorial referred to was published in the Spring/Summer 1985 issue, page 15. Professor Murphy taught at CECOS for nearly 24 years; from 1952 until retirement in 1975.

MUSE prototype returns

In December 1984, MUSE 750 KW Diesel Generator, USN 51-12021, returned to Port Hueneme after over 18 years of continuous overseas service. Still bearing the original "Bureau of Yards and Docks" lettering, this unit constituted the first Navy application of the Electro-Motive Division (EMD) Model 645 engine to shore power generation service.

The plant was procured as an 800 KW prototype for the MUSE Program and shipped to PWC Subic Bay in July 1966. This MUSE was installed at the Cubi peaking plant to furnish needed power generating capability and to provide an operational evaluation of its prototype engine.

The prototype evaluation program proved to be successful, and the experience gained on the engine at Subic was the first step leading to the acceptance of the EMD Model 645 engine as a suitable prime mover for MUSE.

In July 1976, USN 51-12021 was deployed to NAVCOMMSTA Diego Garcia to satisfy an urgent power requirement. The tempo of construction and completion of add-on facilities on Diego Garcia imposed an electrical demand beyond the firm generating capacity of the island power system. The MUSE was located at the main power plant to insure firm power to the island, pending completion of permanent generation.

Upon completion of the phased expansion of the Diego Garcia power plant, the operational deployment was terminated and the unit shipped to NEESA. USN 51-12021 is presently sited at the MUSE Equipment Readiness Yard and scheduled for a complete contract overhaul in order to again enable this MUSE to be available for additional years of reliable power to meet urgent Fleet requirements.

LCdr. Stephen D. Lisse, P. E. NEESA, Port Hueneme, Calif.

Thank you for your letter, LCdr. Lisse. As a reminder to the readers, LCdr. Lisse's article "MUSE = Power for the fleet" appeared in the Winter Issue 1984-85.

Got a question, comment, suggestion, or gripe? Please send it to:

Editor, Code 20M, CECOS, Port Hueneme, CA 93043

Documenting lessons learned:

A NAVFAC consulting engineer's goal . . .

By ARTHUR H. WU, D.SC.
P. E. Va.
Senior Geotechnical Engineering Specialist
and
MICHAEL YACHNIS, D.SC.
P. E. Va.
Chief Engineer
NAVFACHQ

One of the principal functions of the consultants in the Office of the Chief Engineer, NAVFAC, is to solve unique and complex field engineering problems. In fulfilling this function over the years, the consultants have solved many problems while learning many important lessons.

There is great satisfaction in providing a suitable solution to a complex engineering problem, although it is usually preceded by an often difficult process of data gathering, study and evaluation of alternatives, and recommendations for an optimum solution. Since the Chief Engineer insists on competent services from his consultants, that strongly encourages his engineers to take the time to document the problems they have encountered during the course of design, construction, and maintenance of a facility — and to detail the lessons they have learned.

In documenting the lessons learned, valuable experience is put on record for the benefit of the engineers involved and for other engineers. Documentation also allows a consultant to record his mistakes so they may be subsequently avoided.

The importance of documenting lessons learned cannot be emphasized enough. It will allow others to benefit from their experience and to apply this new found knowledge to future consultation services.

Many cases of lessons learned by the consulting engineers in the Office of the Chief Engineer have already been documented and will be published shortly. The following cases are three typical examples.

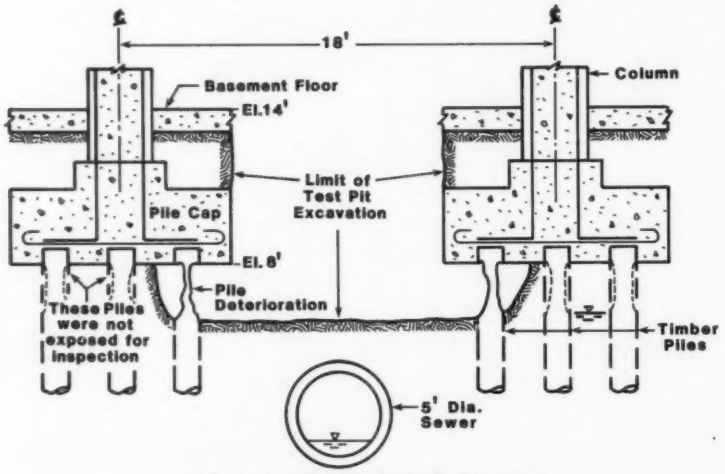


Figure 1 — Observed pile deterioration

Case 1 : *Deterioration of Pile Foundations*

PROBLEM: A 40-year-old, four-story, reinforced concrete structure, supported by timber pile foundation showed structural distress. The building had gradually developed shear and tension cracks in beams, and horizontal tension cracks in some columns. The cause of the cracks had to be found and the structural adequacy of the building needed to be evaluated.

FINDINGS: The sizes, patterns and locations of the cracks were carefully surveyed first to determine the source and severity of the problem. Initial judgment was that the building's structural distress might have been attributed to the settlement of the foundations. Test pits opened beneath two pile caps, where the cracks were most extensive, revealed the timber piles had severely decayed.

The finding led to the opening of six more test pits to uncover the extent of pile deterioration. The results of the investigation showed that piles adjacent to a 5-foot-diameter sewer pipe had badly deteriorated.

Piles away from the sewer pipe were found to be in good condition. It appeared that, over the years, the leaking of the sewer caused settlement of the soil beneath the pile cap. As a result, voids developed and bacterial action supported by the nutrients from the sewage caused the piles to decay (Figure 1).

A structural computation depicted that cracks in the beams had been caused by column settlement resulting in reversal of stresses, while the columns had developed tension cracks from the pull of the downward force.

ACTION: The structural evaluation concluded that the problem did not pose an immediate danger, but that the cracks must be closely monitored. Many monitoring points were established to measure the cracks on the beams and columns.

Crack readings were to be analyzed regularly to assure the safety of the building. The cavities beneath the pile caps were to be filled, and the deteriorated timber piles were to be repaired or replaced with new piles to carry the structural loads.

Case 2: *Stability of Seawalls*

PROBLEM: Seawalls were to be constructed to retain an oyster shell landfill built for the Naval Academy. Underlying the landfill was 60 feet of soft clay. Instability of the landfill had occurred previously. Initial design considered the use of either a floating concrete box seawall or a pile-supported precast concrete seawall.

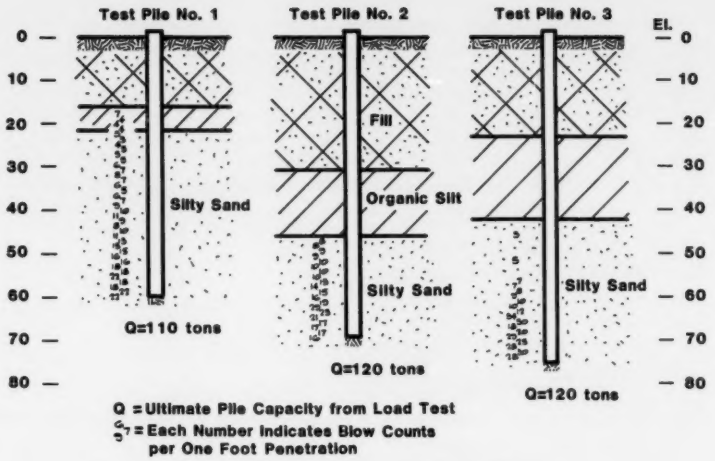


Figure 2 — Design of Seawall Systems

Floating concrete box seawalls sitting on an oyster shell fill would cause seawalls to settle and then tilt, resulting in misalignment of the seawall. Pile-supported precast concrete seawalls would be more expensive, and pile-driving through the oyster shell fill and thick soft clay to the dense sand layer might have involved pile installation difficulties.

FINDINGS: A detailed soil engineering analysis, along with the available landfill settlement records, indicated that the area would continue to settle at a rate greater than what had been previously predicted. While the concrete box seawall could prevent erosion of the backfill, it would be very costly to correct its misalignment once it started to settle and tilt. A pile-supported precast concrete seawall would provide a stable seawall, but it could not prevent backfill erosion and the initial construction cost would be higher.

SOLUTION: The pile-supported precast concrete seawall was chosen to retain the landfill. Steel bearing piles were installed with the aid of some pre-drilling to overcome driving difficulties. Erosion of the backfill behind the seawall did cause settlement of the grade, and maintenance was required regularly. The erosion was eventually avoided by installing timber sheeting against the backface of the seawalls (Figure 2). A stable seawall and pleasant landscaping to the area was thus accomplished.

Case 3: *Pile Driving Difficulties*

PROBLEM: A total of 530 piles, and a 12-inch-diameter shell filled with concrete were to be installed in a non-uniform subsoil to support a physical education center at Annapolis. For pile driving criteria, the Hiley formula was to be used.

After 30 production piles were driven, it was perceived that there were difficulties. The problems were: (1) inability to drive a pile to anticipated depth; (2) pile damage as a result of overdriving; and (3) failure to meet established driving criteria.

FINDINGS; According to the Hiley formula, a blow count of 57 was re-

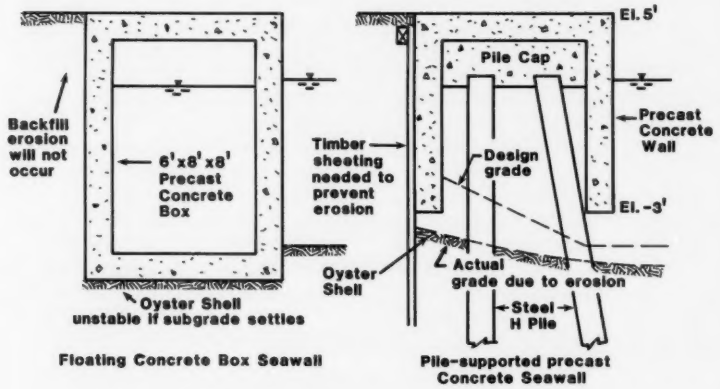


Figure 3 — Pile driving data/pile load test results.

quired for the last foot of driving for a pile to carry 60-ton allowable bearing capacity. A review of the pile-driving records and the results of three pile-load tests showed that the pile-driving criteria being used was excessive, resulting in overdriving of some piles and consequent pile damage (Figure 3).

Many piles actually did not require 60-ton capacity. They required only between 40- to 50-ton capacities. It was incorrect to use a 60-ton, pile-driving criteria to govern all the pile installations when many of the piles did not require 60-ton capacity.

SOLUTION: The results of test pile-driving records and three pile-load tests were used to adjust pile-driving criteria. Appropriate driving criteria corresponding to pile-bearing capacities actually required were adopted. For a 60-ton pile capacity, the driving criteria was modified to read: "Pile shall be driven to a depth where at least 20 feet of the dynamic blow count should be greater than 10 blows per foot."

The load test results indicated that this driving criteria should be adequate for a 60-ton-capacity pile under these soil conditions. After this criteria modification, the remainder of the piles were driven without any of the previous problems.

RECOMMENDATION: It is imperative that not only the NAVFAC Office of the Chief Engineer, but also the NAVFAC family document lessons learned from design, construction, and maintenance of facilities and find ways to disseminate this valuable information. The results will be great cost-savings and benefits to the Navy. □

situation report

The Naval Facilities Contracts Training Center, Port Hueneme, Calif., began conducting procurement training courses on October 1, 1985. The Center is under the direction of Captain B. J. O'Connell, CEC, USN, and is co-located with CECOS, and was established to support the recently expanded training requirements for NAVFAC's contracting personnel.

The Center has assumed control of the three advanced contract administration courses formerly offered by CECOS, (Facility Support Contracting, Construction Contract Modifications and Design Contract Management) and is developing and will offer three new courses (Facilities Cost and Price Analysis, Facilities Negotiation Workshop, and Advanced Facilities Contract Administration). In addition the DOD Contract Law Course is being offered at each EFD with instructors being provided by NAVFAC Counsel. NFCTC is contracting to have DOD courses put on at various locations and is developing correspondence courses and knowledge equivalence validation tests for as many courses as possible.

NFCTC will offer more than 60 courses in FY86 and will train 2,500 to 3,000 students. The number of course offerings in FY87 will be expanded to meet the needs of the field procurement community. An expanded feature article will appear in a subsequent issue of the Navy Civil Engineer.

Naval Facilities Engineering Command planning services have been expanded to include planning in the Integrated Logistic Support (ILS) process.

This new and in-depth commitment will greatly enhance the Navy facilities planning efforts by involving the Planning, Programming and Budgeting System (PPBS) into the acquisition process at a much earlier date.

NAVFAC, with its six engineering field divisions, has the expertise and organizational structure to conduct full scale facilities studies or evaluations. These are used to determine the impact of a particular weapon or sensor system on the existing facilities at the activity.

With this new involvement NAVFAC planners will have ample time to interpret and synthesize the new system design specifications and develop the necessary facilities requirement to assure a timely introduction into the fleet.

The Navy's USE program is in full swing. Mandated by DOD and CNO, the USE program requires Navy installations that generate more than 400 gallons/year of a single solvent to *stop* the disposal of used solvents *and* implement used solvent recycling programs.

To ensure that the Navy meets this goal and initiates recycling programs, CNO has directed that landfilling of most used organic solvents be prohibited. CNO has given NAVFACENGCOM the job of helping Navy installations implement USE programs. This includes development of a USE implementation guide, USE funding programs, and contractor support.

The USE implementation guide will be published by October 1985. An advance copy was sent to the EFDs and major claimants in July. Navy activities will be required to fully implement the USE Program by October 1, 1987.

Large generators of used solvents may be required to implement a USE program by October 1, 1986. You can get assistance and more information from your Engineering Field Division's Environmental Quality staff or from Mr. Ted Zagrobelny, NAVFACENGCOMHQ 1121A, AV 221-8176.

What's the best coal for boiler plants?

By R. A. FITZGERALD

As additional Navy and Marine Corps boiler plants are converted or replaced with coal fired plants, the age old question, "what is good coal" or "what is the best coal for my plant" is asked.

Unfortunately, the meaning of "best coal" is not necessarily the same to everyone. A purchasing agent may consider the best coal to be the lowest cost per ton or the lowest cost per million BTU. A maintenance superintendent may consider the best coal to be one that is the lowest in ash and sulfur because his concerns are to reduce maintenance problems. An operator may consider the best coal to be the one that produces the best furnace conditions, ignition stability, or the quickest response.

When selecting coal for a plant, one must have a reasonable working understanding of the important characteristics of coal and their effect on the plant. Properly selecting the "best coal" challenges the judgment and ability of a competent engineer. To do the job properly, he must know the approximate costs for these plant operations:

- How much a one-percent change in boiler efficiency will affect the cost of annual fuel requirements.
- The cost of soot blowing.
- The cost of coal and ash handling.
- Cost of maintaining fans, soot blowers, pulverizers, refractory, etc.

Varying the characteristics of a coal will impact all these areas.

Proximate analysis is the most commonly used practice to identify the characteristics of a coal. This analysis lists, by percent of weight, the moisture, ash, volatile matter, and fixed carbon of the coal.

The water in coal is called its moisture content and is expressed as a percentage by weight. In general, boiler efficiency will drop about 1/10 of one percent for every one-percent increase in moisture.

Additionally, high surface moisture is undesirable because it will lower pulverizer capacity, impede flow, induce freezing, produce unwanted handling and storage characteristics and, along with sulfur, accelerate corrosion of any metallic surface it contacts.

Another part of proximate analysis is ash content. For coals that are burned in a fuel bed, the combustion efficiency is reduced by about 1/3 of one percent for every one-percent increase in ash content.

Also, the higher the ash content, the greater the tube erosion, slagging, pulverizer wear, and cost of handling the coal in terms of BTU's handled.

On the other hand, coal with a minimum ash content of six to seven percent must be used in continuous ash discharge stokers to protect the metal from furnace radiation.

Volatile matter is another component of proximate analysis. Volatile matter consists of water vapor, carbon dioxide and methane which is released first in the combustion process. In stoker firing the volatile content is not significant, however, in pulverized coal boilers a high volatile coal is desirable to improve ignition and flame stability, and allow quicker response to load swings.

The final part of proximate analysis is the fixed carbon. It is obtained by subtracting the moisture, ash, and volatile matter and expressing the remainder as a percent by weight of fixed carbon. By itself, fixed carbon is not significant for most steaming operations.

The most important single item in selecting the coal from an economic point of view is its heating value; i.e., the amount of heat produced per pound of coal. The higher the heating value of coal, the less coal that has to be burned to give a certain quantity of heat.

Most boilers can burn a wide range of heat-valued coal. Their rated capacity is usually limited by factors such as draft loss and waterside circulation problems long before being affected by the heat value of the coal.

Sulfur is another important characteristic of coal. In recent years, the sulfur content has become more relevant due to Federal and local government efforts to preserve the Nation's air quality.

Also, high sulfur coal, when combined with high moisture, is undesirable for long-term storage because of its spontaneous combustion, its inability to weather, and storage pile runoff.

Another factor to consider when selecting coal is the fusion temperature of the ash. When this temperature is reached, the ash becomes plastic and sticks to tubes and also interferes with the uniformity of the firebed on stokers. A minimum ash fusion temperature must be specified on all coal purchases.

Grindability is a characteristic of coal that represents its ease of pulverizing and is one of the factors used to determine the capacity of a pulverizer. The index is relative; 100 represents coals which are easy to pulverize; smaller values such as 40 represent hard, difficult coals to pulverize.

Pulverized coal plants usually specify coal in the range of 50 to 55 grind. Free swelling index (FSI) is another relative scale which describes the characteristics of coals when burned on a grate.

Coals in the range of 1 to 6½ are considered the best for generating steam, and coals in the range of 7 to 9 are best suited for manufacturing coke. FSI is of little significance to pulverized coal fired boilers.

Size is another important characteristic of coal and is largely governed by the type of firing equipment at an installation. Coal is normally specified to have a maximum top size with a certain percentage passing through a one-quarter-inch round-hole screen.

This percentage is known as "fines" and its role in the handling and burning of coal is very important. Too high a percentage can result in broken conveyor belts, unloading difficulties, and excess stack loadings. Too small a percentage will effect ignition and flame stability.

Eight Navy and Marine Corps plants are now burning coal and no two similar plants burn identical specification coal. The selection of coal for these plants is entirely controlled through bid specifications for each installation's requirements.

Thus, we must carefully consider the limits and responses each of these coal characteristics will have on our plant, before we can decide upon the "best coal" to meet our installations needs. □

news worth reviewing

Gulfport Seabees help special kids

Four Seabees from the Naval Construction Battalion Center recently lended their construction talents to a special project — one of helping to build the lives of 50 handicapped children from the South Mississippi Retardation Center (SMRC) in Long Beach, Miss., as reported by JO3 Jason Torres.

BU1 Butch Oberembt, CBC Career Counselor, UT1 Uwe Rheinfrank and CM2 Mike McDonald from the Naval Construction Training Center, and BU3 Dan Finerman of NMCB-133, volunteered their time and energy to help with SMRC's "Fun in the Sun" summer camp which was held at the Seashore Methodist Assembly in Biloxi.

The camp is held annually for one week to help special children interact with one another in a spirit of emotional, physical and mental growth.

The children were involved in activities such as swimming, arts and crafts, bowling and all sorts of other indoor and outdoor games. The camp staff rotated between 20 full time and 30 part-time counselors, which provided for a more one-on-one relationship with the children.

Although most of the funds that went into sponsoring the camp were donated by the City of Biloxi and the private sector, the love and encouragement displayed during the week-long camp was donated by volunteers such as Oberembt and friends.

"I think it's unanimous when I say we will be here any time these kids will have us around. We wouldn't miss a chance like this," Oberembt said.

BU1 Butch Oberembt helps a struggling youngster as he attempts to swim during the "Fun in the Sun" summer camp.

New Technical Director at NCEL

Dr. Robert N. Storer, head of the Shore Facilities Department for almost three years, has been selected Technical Director of the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, Calif.

He succeeds Dr. Donald L. Birkimer who retired recently.

In his new position, Storer is responsible for the development and execution of a diversified technical program and a $44 million annual budget. The top civilian employee, he supervises a professional staff of 200 engineers and scientists and manages approximately 325 work units.

Storer, who joined NCEL in 1964 as a general engineer, becomes the Laboratory's fifth technical director since it was established at Port Hueneme in 1950.

Design excellence awards announced

The Naval Facilities Engineering Command, in collaboration with the American Society of Interior Designers, announced nine winners in the fourth biennial interior design excellence awards program.

Winners of the first honor awards are the Northern Division of NAVFACENGCOM for the Alert Force Facility at Griffiss AFB, Rome, N.Y., and GHI Architecture Interior Design in San Francisco for the child care center at Naval Air Station, Lemoore, Calif.

Winners of the seven awards of merit, which are unranked, were:

- Atlantic Division of NAVFACENGCOM in Norfolk, Va., for the chapel and religious education building at Naval Security Group Northwest in Chesapeake, Va.
- GHI Architecture Interior Design for the personnel support detachment at NAS, Lemoore, Calif.
- Northern Division of NAVFACENGCOM for the Fleet Material Support Office, Navy Ships Parts Control Center in Mechanicsburg, Pa., the child care center at Naval Air Station, Brunswick, Maine, the enlisted barracks at Naval Submarine Base, New London, Conn., the aviation supply office at the Aviation Supply Depot in Philadelphia, and the family services center at the Philadelphia Naval Base.

Lab introduces students to science

"When we invest in the future, our highest interest concern is 'the human resource,' " said Ann E. Keneman of the Naval Civil Engineering Laboratory (NCEL), Port Hueneme.

Keneman, a management analyst, explained that one way in which NCEL "invests" is by supporting the MESA (Mathematics, Engineering, and Science Achievement) program at local high schools.

"Through tutorial programs as well as educational field trips, NCEL creates an interaction between students and engineers to help prepare them for university-level study in a variety of scientific fields," Keneman added.

Hosting a career awareness field trip recently, NCEL engineers and scientists welcomed students from Channel Islands, Port Hueneme and Oxnard High Schools participating in MESA's summer program. The students were invited to investigate career opportunities, summer jobs, and work/study (Cooperative Education) programs at the Laboratory. Also, students were introduced to state-of-the-art computer-aided design systems.

"We want to show them that new technology is interesting and is nothing to be afraid of," said Jose Chavez, an electrical engineer at NCEL.

Chavez, a former Channel Islands High School MESA student, and current NCEL volunteer MESA tutor, encouraged the students to strive for good grades and meaningful part-time employment.

Chavez told the students that NCEL's Cooperative Education program allowed him to apply the mathematic and technical concepts he was learning in school to real life situations.

"NCEL gave me the opportunity to find out my likes and dislikes in my field of study before I graduated from college," he added.

A new challenge for CEC officers

By LCDR HAL THOMAS
P.E., Va. and Wash.

Communication is the byword for success and accomplishment in today's exceedingly complex world. Voice communication and the letter have been augmented by automated reports, telecommunications and electronic mail. In order to effectively perform in all jobs, the Civil Engineer Corps Officer must be familiar with all available methods of automation and communication and strive to utilize these systems to best support the organization.

Nowhere does the importance of effective office automation and automated communications become more evident than in the daily operation of the Engineering Field Divisions (EFDs) and their subordinate contracting and inspecting offices (OICs, ROICs, OICCs, ROICCs).

The degree of operating resources provided to the EFDs and subsequently made available to the ROICCs are directly associated with the accuracy and timeliness of data imput.

The objective here is not to expose the reader to a treatise on FACSO, AMALGAMAN, CMS, RCMS or DMIS but to emphasize the importance of getting involved with the "system.

The EFD justifies its existence, financially and physically, on the generation of Work-In-Place (WIP) by its satellite ROICC/ROIC offices and contracts awarded under contracting authority delegated to the local Public Works Officer/OICs/OICCs.

In the past, on a monthly basis, the ROICCs and the ROICs provided the latest WIP and contract progress figures to the EFD on a marked-up centrally generated computer report. The EFDs would review this information, enter it into their terminals, and forward it to the Facilities Systems Engineering Office (FASCO) and Port Hueneme to be entrered into the "system." More on how this information was used later.

This way of doing business was time consuming since it involved numerous people handling the data, exposed the data to entry mistakes and did not allow the man-in-the-field to customize the data to serve leadership and management needs.

Office Automation equipment and software have been provided to the ROICCs within the last year to permit imput of the construction contract data to FACSO directly through telecommunications, allow local manipulation of the data and speed up routine office administrative work. The EFDs are conducting continuing training in the use of this equipment and programs so maximum benefit can be gained.

One of the most essential ingredients to the proper management of any enterprise is the timely ability to objectively and accurately identify the level of performance being achieved against predeterimined goals

The Goal Progress Reporting System (GPRS) allows for automated review and evaluation of progress against the established goals or standards. The Naval Facilities Engineering Command carries out its mission under a concept of management by objectives, extending it through definitive areas of end-product responsibility called "programs." Within each program are a group of goals or objectives to which we subscribe.

The GPR, as it is called, is compiled at Headquarters from data imput into the system. This is destributed to all NAVFACENGCOM field activities, headquarters program managers and coordinators, and other interested personnel, and forms the basis for the command performance appraisal process.

NAVFAC extracts data concerning WIP generation and change order processing, among other items, from the system and reviews it to determine how an EFD is performing. Trends are reviewed to determine if there are problems requiring EFD or FACSO assistance and action is taken accordingly.

The major impact is that the assignment of fiscal year financial and manpower resources to the EFD and their subordinate offices is based on the quality of data in the system and how the EFD is perceived as meeting the goals.

Around the end of the second quarter of every year, each EFD submits a tentative operation plan for the upcoming fiscal year to NAVFAC. As part of this plan, the WIP for next fiscal year is projected by the EFD and through the use of various algorithms, the necessary EFD support requirements are generated.

When it comes time to divvy up the resources to the various EFD's, NAVFAC examines the current year's progress against the EFD's projection to determine the accuracy of resource planning. If the system's data does not show that the EFD is able to accurately project requirements, there is a great possibility that resources provided to EFD for the next fiscal year may be reduced.

If resources are decreased, this reduction is passed down the chain to the ROICC in terms of reduced manning levels, fewer vehicles and decreased administrative support. In order to have the resources to properly do our job, we need to ensure that the record (system) accurately reflects our level of effort.

The Civil Engineer Corps Officer must be intimately involved to ensure that the correct data is entered into official automated record systems. A ROICC, for example, should be concerned that the maximum allowable WIP consistent with good contract management is reported on all contracts administered and that the system accurately reflects the status of all contracting actions.

The overall responsibility for this function cannot be delegated to the administrative staff within the office. Civil Engineer Corps Officers must take the initiative to ensure that the system has data to support the organization because the manager will have to respond to whatever resource changes occur.

We should be in the mode where the *system* feeds our needs, not where we exist to feed the system. □

Hazardous S

What ever

manager sho

On a typically hot, humid August afternoon two warehousemen of the Navy Supply Center in Norfolk, Va., were doing their routine job — handling hazardous chemicals. They were repackaging deteriorated cardboard boxes of expired six-ounce containers of calcium hypochlorite (CHC), a powerful oxidizer, into new triple-wall cardboard containers.

The small plastic bottles were brittle and cracked having apparently been exposed to high heat and humidity at their previous location. When the new containers were full, the workers went to get more.

Within minutes, flames and smoke reached 1000 feet in the air and the temperature of the fire hit a high of 3000° F, leaving one fireman injured and over $1 million in damages before it was extinguished three hours later.

Apparently, the fire originated when the CHC contacted the wax-coated triwalls and reacted with the organic material in the wax.

Fortunately, catastrophic events such as these are rare occurrences. Unfortunately, the accident potential exists at most Navy and Marine Corps installations. Thousands of chemical substances are used, stored, moved, processed and transported in and out of Naval installations every day.

A large number of these substances are released as the result of human errors, accidents, equipment failures and other "unscheduled events." Such chemicals include flammable, explosive, poisonous, oxidizing, toxic and corrosive substances which present hazards and dangers of which personnel are often unaware.

Hazardous substance (HS) incidents require prompt and effective action to minimize potential adverse effects to people, property and the environment. Public awareness, personnel safety, environment protection, expense of cleanup and impact on the Navy mission are major considerations when dealing with HS incidents.

Careful pre-planning and coordination are necessary to achieve the required level of response readiness. The cost of pre-planning is relatively small when compared to possible cleanup costs, injury to workers, production down-time, expensive fines and lengthy litigations.

Navy facility managers need to know their responsibilities and legal requirements for HS spill planning, organizational assistance and resources, response personnel and equipment, and training in response techniques.

The following paragraphs review the fundamentals of HS spill response and describe the responsibilities Navy leaders share to ensure that activities are prepared for HS emergencies.

Federal Response Program

In 1980, the President signed the Comprehsive Environmental Response, Compensation, and Liability Act (CERCLA) or "Superfund" legislation. CERCLA provides for spill reporting, liability compensation, cleanup, and emergency response for hazardous substances (excluding oil) released into the environment and the cleanup of inactive disposal sites.

As required by CERCLA, the Environmental Protection Agency (EPA) published in 1982 a revised National Contingency Plan (NCP) under rule 40 CFR 300 which sets guidelines for Federal response to environmental pollution incidents.

The NCP provides response by coordinating the efforts of twelve participating agencies of the Federal government (including DOD) and a number of specially designed pollution control and emergency response forces and resources.

The organization is comprised of a National Response Team (NRT), a National Response Center (NRC), Regional Response Teams (RRT), Federal On-Scene Coordinators (OSC) on an area/regional basis and special forces and resources (Figure 1).

Navy Spill Response Organization

In response to Federal, state and local laws/regulations and Executive Orders, the Navy has set forth its environmental policy in OPNAVINST 5090.1 (Environmental Protection and Natural Resources Manual). The manual assigns responsibilities for complying with legislation and implementing a Navy-wide program for protection of the environment.

Chapter 13 establishes a Navy organization for response to oil and hazardous substance spills, and requires Navy activities to develop spill prevention and contingency plans (Figure 2).

The Navy On-Scene Coordinators (NOSC) are senior Navy officials appointed on an area basis to coordinate response to major oil and HS releases. The NOSCs must have authority to commit Navy resources and access funds for spill cleanup, and know when to request support from local, state, or Federal sources (e.g., EPA, USCG) or activate the RRT.

NOSCDR and On-Scene Operations Teams (OSOT) are designated by each shore activity to conduct local response.

By LCDR W.L. NELSON, CEC, USN
P.E., Calif.
and
JORGE R. PENALBA
E.I.T., Calif.
NEESA, Port Hueneme, Calif.

NOSCDR is a Navy official charged to direct operations for the initial response, control, containment and cleanup of HS spills.

An OSOT may be comprised of military and civilian personnel from various departments (Figure 3). The OSOT should be able to rapidly deploy personnel and equipment, provide the multi-disciplinary skills and resources needed to handle chemical spills, contain and cleanup small to medium size spills, and provide effective containment and control of large spills until additional assistance arrives.

Many Navy fire departments now are responding to activity HS spills and are performing emergency entry/rescue and spill assessment and control as part of their firefighting duties. Fire departments are assisted in these functions by base paramedics, security, and safety personnel. Likewise, most activity public works departments maintain the capability to conduct cleanup and restoration operations and to dispose of the recovered spill material.

Contingency Planning

Contingency plans for Navy activities handling HS are specifically required by OPNAVINST 5090.1. Contingency planning provides the opportunity for identifying areas where HS exist, and developing the capability to respond when spills occur. The Navy requires three levels of HS contingency plans: area plans, local activity plans, and site-specific plans.

Area plans provide for the coordination of effective area-wide responses by Navy forces and other organizations such as Federal, state, and local agencies and contractors, to incidents which exceed the capabilities of area activities.

Local activity plans establish policy, responsibilities and procedures for the immediate response, control and cleanup of HS spills under an activity's jurisdiction. Local activity plans should specify a response organization and define the responsibilities of each member. A good activity plan will clearly identify specific response actions such as notification procedures, emergency rescue, evacuation, cleanup alternatives, and cost recovery procedures. The plan should also contain information on potential spill sites, vulnerable areas, local response capability including location and quantity of response equipment, and technical references. The plan should be implemented by a base instruction.

Site-specific plans should be prepared for sites with significant potential for HS spills such as loading and unloading areas, material storage areas, hazardous waste facilities, shops and along transportation routes. These plans should include actions to be taken by site personnel in the event of a spill, and key information about the facility layout, chemical inventory, potential hazards, probable spill migration routes, list and location of emergency equipment at the facility, and names with telephone numbers to notify in case of a spill. Materials Safety Data Sheets (MSDS) should be obtained from the Safety Office for each chemical on-site and included in the site-specific plan.

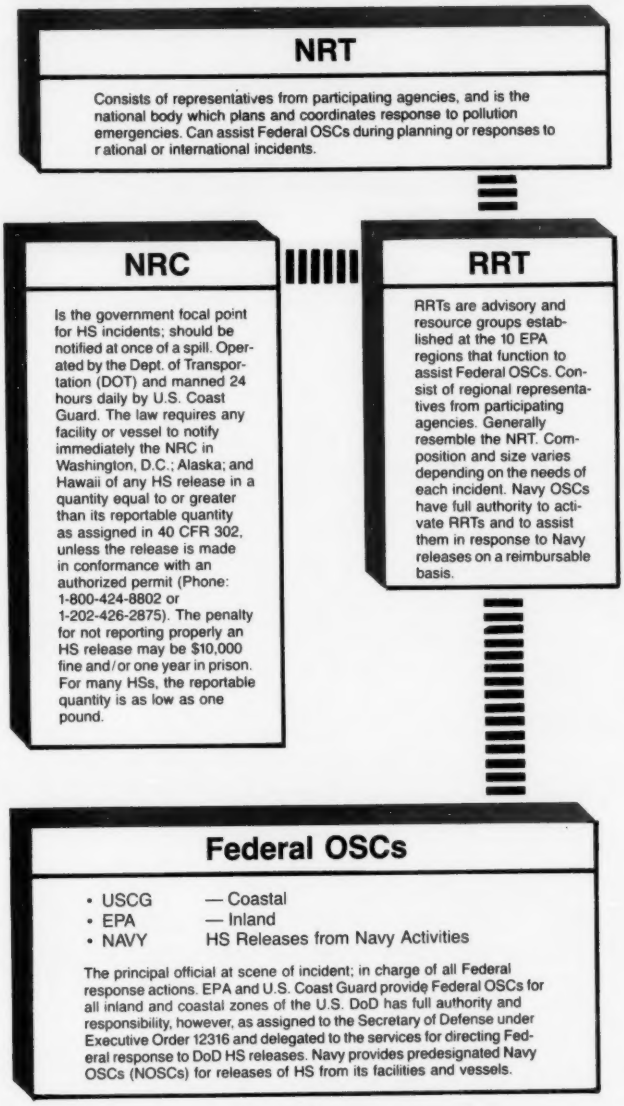

NRT
Consists of representatives from participating agencies, and is the national body which plans and coordinates response to pollution emergencies. Can assist Federal OSCs during planning or responses to r ational or international incidents.
NRC
Is the government focal point for HS incidents; should be notified at once of a spill. Operated by the Dept. of Transportation (DOT) and manned 24 hours daily by U.S. Coast Guard. The law requires any facility or vessel to notify immediately the NRC in Washington, D.C.; Alaska; and Hawaii of any HS release in a quantity equal to or greater than its reportable quantity as assigned in 40 CFR 302, unless the release is made in conformance with an authorized permit (Phone: 1-800-424-8802 or 1-202-426-2875). The penalty for not reporting properly an HS release may be $10,000 fine and/or one year in prison. For many HSs, the reportable quantity is as low as one pound.
RRT
RRTs are advisory and resource groups established at the 10 EPA regions that function to assist Federal OSCs. Consist of regional representatives from participating agencies. Generally resemble the NRT. Composition and size varies depending on the needs of each incident. Navy OSCs have full authority to activate RRTs and to assist them in response to Navy releases on a reimbursable basis.
Federal OSCs
• USCG — Coastal
• EPA — Inland
• NAVY HS Releases from Navy Activities
The principal official at scene of incident; in charge of all Federal response actions. EPA and U.S. Coast Guard provide Federal OSCs for all inland and coastal zones of the U.S. DoD has full authority and responsibility, however, as assigned to the Secretary of Defense under Executive Order 12316 and delegated to the services for directing Federal response to DoD HS releases. Navy provides predesignated Navy OSCs (NOSCs) for releases of HS from its facilities and vessels.

Figure 1 — National Contingency Plan

Substance:
ry facility
hould know

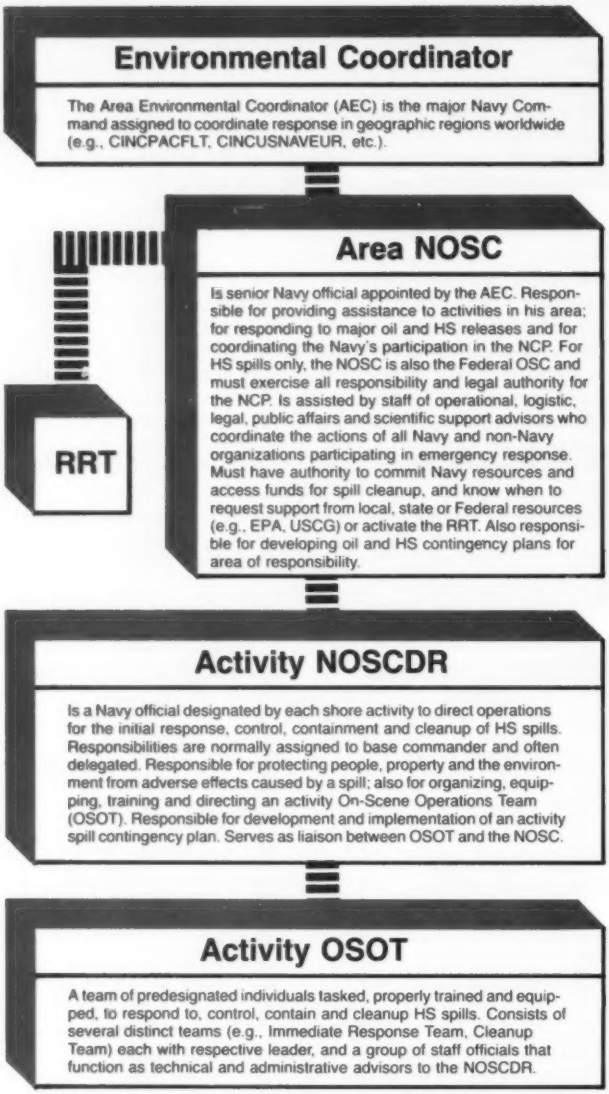

Environmental Coordinator
The Area Environmental Coordinator (AEC) is the major Navy Command assigned to coordinate response in geographic regions worldwide (e.g., CINCPACFLT, CINCUSNAVEUR, etc.).
Area NOSC
Is senior Navy official appointed by the AEC. Responsible for providing assistance to activities in his area; for responding to major oil and HS releases and for coordinating the Navy's participation in the NCP. For HS spills only, the NOSC is also the Federal OSC and must exercise all responsibility and legal authority for the NCP. Is assisted by staff of operational, logistic, legal, public affairs and scientific support advisors who coordinate the actions of all Navy and non-Navy organizations participating in emergency response. Must have authority to commit Navy resources and access funds for spill cleanup, and know when to request support from local, state or Federal resources (e.g., EPA, USCG) or activate the RRT. Also responsible for developing oil and HS contingency plans for area of responsibility.
RRT
Activity NOSCDR
Is a Navy official designated by each shore activity to direct operations for the initial response, control, containment and cleanup of HS spills. Responsibilities are normally assigned to base commander and often delegated. Responsible for protecting people, property and the environment from adverse effects caused by a spill; also for organizing, equipping, training and directing an activity On-Scene Operations Team (OSOT). Responsible for development and implementation of an activity spill contingency plan. Serves as liaison between OSOT and the NOSC.
Activity OSOT
A team of predesignated individuals tasked, properly trained and equipped, to respond to, control, contain and cleanup HS spills. Consists of several distinct teams (e.g., Immediate Response Team, Cleanup Team) each with respective leader, and a group of staff officials that function as technical and administrative advisors to the NOSCDR.

Figure 2 — Navy Spill Response Team Structure

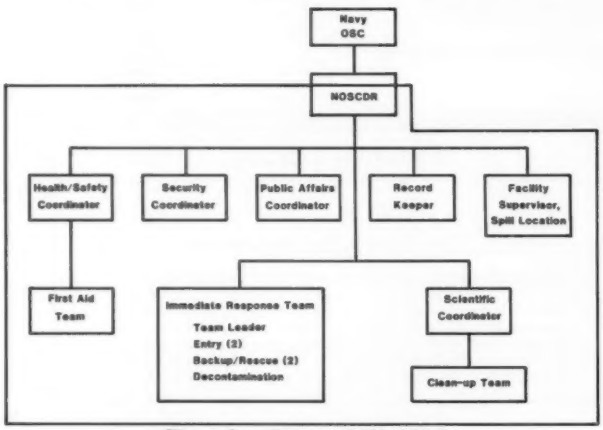


Figure 3 — Suggested HS OSOT

Site floor plans are vital to show the location of alarms, emergency exits, stored chemicals, switch boxes, shut-off valves, drains, hydrants, fire extinguishers, valves and pump controls that could stop spillage, and pre-positioned spill response equipment (e.g., respirators, sorbents, sand bags, spill kits, etc.). Evacuation procedures and designated assembly areas outside the facility should also be established.

Depending upon the severity of an incident, response may be at the facility or local level, an area or regional response, or conceivably, a national response. Federal and Navy contingency plans must be coordinated at various levels to ensure consistency, coordinated responses, and the best use of resources.

NAVFAC is the lead military service for information and technical guidance for oil and HS contingency planning and is responsible for assisting NOSCs and local commands with planning and training.

NAVFAC is assisted in this role by NAVSEA OOC, the NAVFAC Engineering Field Divisions (EFDs) and the Naval Energy and Environmental Support Activity (NEESA).

NEESA is preparing a contingency planning and response manual to be the primary guidance for Navy contingency plan development and spill response. As part of the manual, example contingency plans for oil and HS spills have been written.

When completed, the manual will contain detailed planning guidance with model formats, a binder, and section tabs to be filled in by each activity for ready access to key information.

Personnel Safety

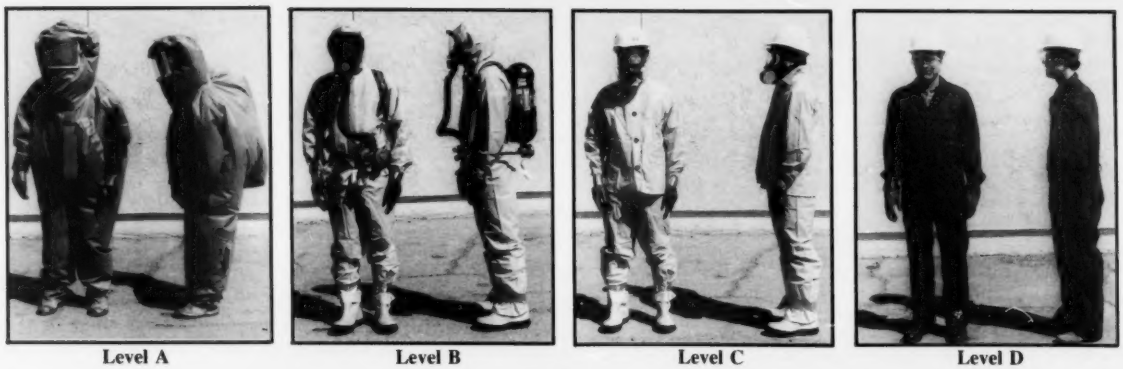
Hazard recognition, evaluation and control during HS spills are essential to protect public health, property, and the environment. The primary consideration must be for the health and safety of response personnel. Prior to actually performing containment of a spilled hazardous substance, the NOSCDR must determine the physical and chemical hazards associated with the spilled substance and make a decision regarding appropriate protective equipment to be used by response personnel.

There are two types of personal protective equipment: respiratory protection and protective clothing. An adequate combination of these two types of equipment must be used to protect the worker on the three routes of chemical exposure: skin and eye contact, inhalation and ingestion.

Respirators protect the lungs and respiratory tract against toxic vapors, gases, or fumes, and lack of oxygen. Air purifying respirators remove toxic air contaminants by means of chemical sorbents and high-efficiency filters. They are specific for the type of substance, require fresh air and have concentration limits beyond which they are ineffective.

Self-Contained Breathing Apparatus (SCBA) and airline respirators are used to supply breathing air to the workers when toxic concentrations are too high or there isn't enough oxygen in the air.

SCBAs are available in 30- and 60-minute units and provide more mobility and freedom. Airline respirators can supply three to five hours of air for six workers from a remote air supply, but are constrained by the length of and potential damage to the umbilical.



Level A | Level B | Level C | Level D

Protective clothing is used to protect the worker against substances that are destructive to or readily absorbed through the skin and eyes by liquid splashes, high levels of gases or particulates, or other means of direct contact. It also protects against eye, head, or foot impact hazards and affords hearing protection.

Protective clothing ranges from gloves and boots to splash gear and fully encapsulating suits. The suits may be disposable and are made of a variety of materials including butyl rubber, neoprene, polyvinyl chloride, polyethylene, saranex, and viton.

No one material can protect against all chemicals. Manufacturers have developed chemical resistance charts that rate the protection afforded by each material for specific or groups of chemicals. Chemical splash suits provide adequate protection against liquid splashes while fully encapsulating suits also protect against harmful gases.

The EPA has established four levels of protection which use various combinations of equipment to protect response personnel based on the type and degree of hazards present (Figure 4).

When the type of chemical, concentration, and potential hazards are not known, the appropriate level of protection must be selected based on experience, professional knowledge, and judgement until the hazards can be identified. Other considerations that determine the level of protection include the type of work assignment and the ambient temperature and humidity.

The lack of natural ventilation while working in protective clothing can easily lead to heat stress. If not properly accounted for by frequent rest periods, especially on very hot days, excessive heat can lead to rashes, cramps, exhaustion or heat stroke.

Communications are difficult in Levels A, B, and C due to voice muffling and lack of a telephonic/radio link with the command post. Additionally, faceplate fogging frequently obstructs the vision of the encapsulating suit wearers.

While this equipment reduces the potential for contact with HS, safeworking practices, standard safety procedures, a medical surveillance program and proper education and training are essential to ensure the health and safety of responders.

Standard Operating Procedures & Work Zones

As part of a comprehensive safety program, standard operating procedures (SOPs) provide instructions on how to accomplish specific tasks in a safe manner. The EPA has developed SOPs for the safe entry and control at HS incidents. The procedures are generic and independent of the type of incident, and are adapted or modified to meet site-specific requirements.

An initial on-site survey is normally conducted to determine immediate and potential hazards such as fire, explosion, lack of oxygen, airborne contaminants, or pooled HS that could effect the cleanup effort. The initial entry team collects and verifies as much information as possible about the incident before entering the site. Container levels, markings, shipping papers and transportation placards help identify the chemicals involved.

Binoculars are normally used to read placards and labels from a safe distance. Asking site personnel and consulting chemical inventories in the site contingency plan and HWMP are also helpful.

LEVEL A

Provides the highest level of respiratory, skin, eye, and mucous membrane protection (i.e., fully encapsulating suit and SCBA). Generally used in situations where extremely hazardous substances are known to be present in high atmospheric concentrations and where Level B splash gear does not offer adequate skin protection.

LEVEL B

Provides the highest level of respiratory protection and a lesser level of skin and eye protection (i.e., splash gear and SCBA). Generally used in situations where chemical is known, the atmosphere is oxygen deficient, contains immediately dangerous to life and health (IDLH) concentrations of HS, or where skin contact with an HS is highly unlikely. This level of protection will normally be the minimum used for an initial response unless the respiratory hazards associated with an HS allow for a lesser level of respiratory protection than a SCBA.

LEVEL C

Is suitable when type of airborne substance is known, concentrations are measured, criteria for using air-purifying respirators met, and skin exposure is unlikely (i.e., splash gear and air purifying respirator with appropriate cartridges). This level of protection requires continuing measurement of air contaminants to ensure that IDLH concentrations do not exist and that the concentrations of HS do not exceed the service limits of the canister.

LEVEL D

Is primarily a work uniform and should not be worn in any hazardous environment. Used when there is no indication of hazardous conditions and work precludes contact with any HS.

Figure 4 — Four levels of protection

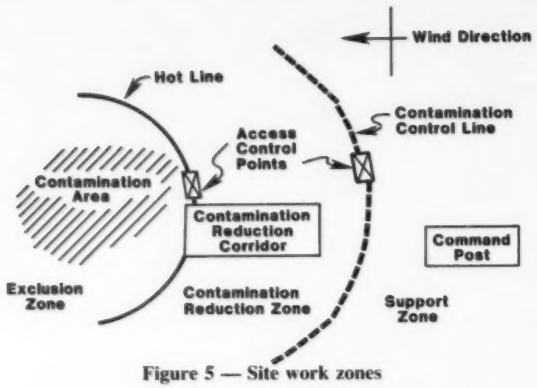


Figure 5 — Site work zones

Based on the available information, the NOSCDR assesses the hazards, determines the need to go on-site, and identifies the safety requirements, after consulting technical references, MSDSs, and other information sources.

A variety of monitoring instruments are available to detect atmospheric hazards. Combustible Gas Indicators (CGI) are used to detect flammable vapors. Oxygen meters measure oxygen concentration in the air. The combined use of these instruments is vital for detecting flammable or explosive atmospheres.

Flame Ionization Detectors (FID) can be used to detect certain toxic atmospheres. Direct reading colorimetric indicator tubes provide a quick and easy-to-use method to estimate the airborne concentration of specifically known HS.

Periodic ambient atmospheric monitoring of the site for these and other parameters (e.g., water sampling and analysis, or radiation) when appropriate, is encouraged due to the changing conditions normally inherent during spill operations.

One of the most important steps during an incident is the physical control of the site. There are several elements to this control including evacuation, access control, command post, site work zones and decontamination procedures. A site must be controlled to reduce the possibility of contact with any contaminants, and to minimize the migration of contaminants from the effected area.

Site work zones are generally divided into an Exclusion (or Contaminated) Zone, a Contamination Reduction Zone, and Support (or Clean) Zone (Figure 5). Movement of personnel and equipment between zones and onto the site is limited by access control points. This classification serves to identify areas where protective equipment may be required and helps to prevent the spread of contamination outside the contaminated zone.

The Contamination Reduction Zone (Figure 6) provides for controlled transition between the contaminated and clean areas, to minimize the physical transfer of HS on people, equipment or in the air. An area within this zone is designated the Contamination Reduction Corridor or Decon Area. Personnel leaving the Exclusion Zone must go through the Decon Area to wash-down and remove their gear, take a field shower and redress before entering the Clean Zone.

Decontamination consists of physically removing contaminants from response gear. The more harmful the contaminant, the more extensive and thorough the decontamination must be. Well defined work zones and correct doffing procedures for protective equipment, minimize cross-contamination from clothing to wearer, equipment to personnel and one area to another (Figure 7).

Complete decontamination of environmental suits should be accomplished on-site when possible. The decontamination procedures to use and size of the Decon Area will depend on the type and amount of contamination, level of protection, type of protective clothing worn, and amount of space available. A corridor of 75 feet by 15 feet should be adequate for a complete Level A decontamination procedure.

Contaminated clothing must be left in the Decon Area until properly decontaminated. Portable instruments, clipboards with notes and sketches, and lab samples used by the entry team need to be passed routinely through the Decon Area back to the command post, where overall response decisions are made. Modified Decon procedures are used to change the entry team's SCBA bottles.

Wearing disposable suits over more expensive environmental suits makes the decontamination process easier. Finally, it cannot be stressed enough that prior training and care in following the basic procedures must be observed by all team members to prevent cross-contamination.

Support equipment and the command post are located in the clean area of restricted traffic. The location of the command post and other support facilities depends on several things, including: accessibility, wind direction (the command post should never be placed downwind of the Exclusion Zone), and other resources such as buildings and utilities.

The NOSCDR should have a plan for handling a variety of medical emergencies. Injuries such as heat stress, chemical exposure, and physical injury may require first aid or CPR. If prompt life-saving medical treatment is required (e.g., stopping massive bleeding), decontamination procedures should be omitted, first aid given, and the victim taken immediately to the medical facility. The medical staff

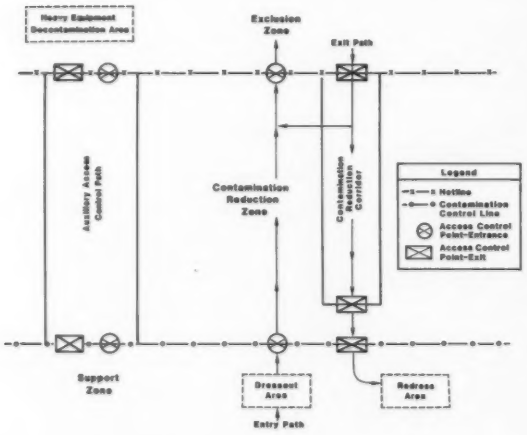


Figure 6 — Contamination reduction zone

Responders in Level A protection inspect a drum label before proceeding with corrective measures.

should be advised on matters involving decontamination.

Many activities are developing fully equipped HS response trailers which provide central control and portability of response equipment, a reference library, better organization at an emergency site, and a point from which to base a command post.

Containment and Cleanup

The techniques for controlling the release of an HS depend on whether it occurs on land, water, or is airborne.

Localized releases in the air can be contained (or dispersed) using several techniques including knockdown misting, sorbent applications, natural ventilation, or by use of fans and blowers. Considerations for knockdown misting include possible reaction between the material to be removed and the water mist, whether a suitable setup can be established to collect the mist water, wind dispersion that would render the method ineffective and the possibility of creating a worse water pollution problem. Sorbents effectively reduce the vaporization rate of volatile liquids.

Hazardous substances released on land can be contained in a number of ways. These include: drain covers, sand bags, sorbents, herding, earthen dikes, polyurethane and concrete foams, and excavation sumps.

Some of the considerations for implementing these techniques include rain, soil, or subsoil conditions that may decrease the method's effectiveness; presence of wells or drains that provide transport routes for the HS; whether the repercussions of the method may be more harmful than natural dispersal and/or breakdown of the material; and whether the method can contain the release quickly and effectively.

The use of vacuum trucks, pumps, high pressure water and steam should be considered for larger spills.

Releases in water pose special problems since materials may go into solution, float, or sink. Methods of containment include: sorbents, floating barriers (booms), gelling agents or dispersion devices, diversion of uncontaminated water, or the containment of the entire water body by the use of dams or dikes.

Considerations for these methods include deployment logistics, spill volume and flow, soil structure or bottom composition, and wind, waves, currents or tidal action that would affect the method's effectiveness; whether dams, channels, or bypasses affect the control; can it be accomplished quickly and safely; and could repercussions of the method be more harmful than the natural dispersion of the material.

The response team is limited only by its own imagination and creativity in devising containment techniques. The common concern remains the prompt containment of the spilled HS while protecting the health and safety of each team member.

In all situations the dilution of a spilled material, for example with water, should be avoided and used only as a last resort. Dilution oftentimes reduces control of the spill and increases the overall cleanup costs. The responsibility for cleanup is typically a Public Works or contracted effort. Methods of cleanup will be briefly reviewed.

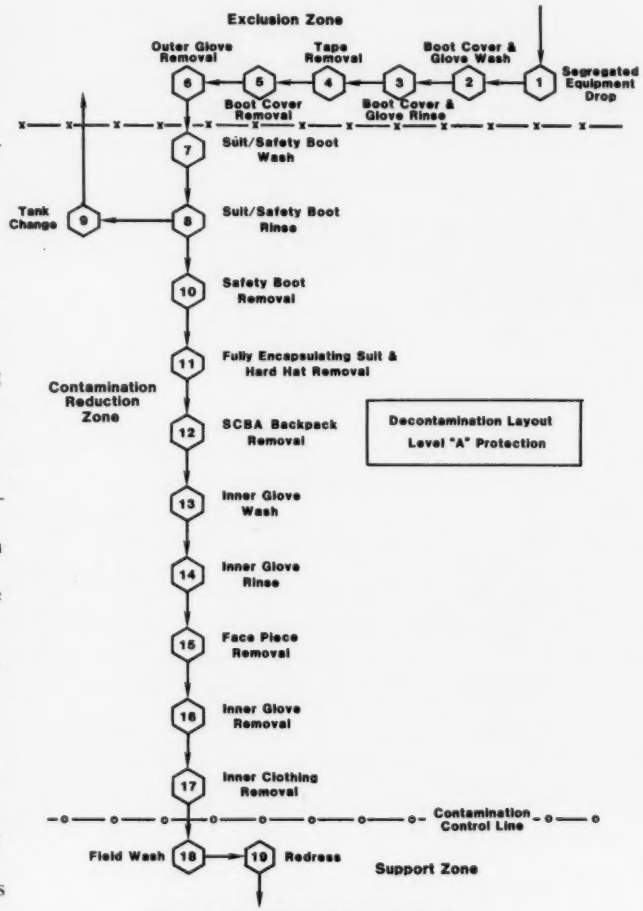


Figure 7 — Well-defined work zones

Responders in Level A protection return a spilled oxidizer drum to its upright position.

Chemical neutralization is a common method of on-site treatment for acid or alkaline substances, for the purpose of pH adjustment. In many cases neutralization is a simple and reliable process for treating HS with minimal risks to the environment.

Chemical precipitation, oxidation/reduction, ion exchange and dechlorination are other techniques for on-site treatment. The pitfalls of chemical treatment include: over-treatment, generation of heat, formation of toxic products, under treatment and missed treatment.

Other on-site treatment methods are biological means, which are similar to sewage treatment practices; carbon adsorption which is relatively expensive; and solid-liquid separation using screening, sedimentation, flotation, filtration and centrifugation techniques.

In each case a chemist or health and safety specialist should be consulted for specific guidance regarding the treatment method to be used.

When on-site treatment is not suitable, it may be necessary to remove hazardous liquids or excavate contaminated soil for off-site treatment or disposal. Off-site treatment is normally a more expensive process due to the handling and shipping costs associated with moving the HS to a treatment site.

Training

The keys to a successful spill response organization are training and practice! A variety of formal spill response training courses are available from government and private organizations. Two courses are available for Navy and Marine Corps personnel. The NOSC/NOSCDR Course is designed to train senior Navy officials about their spill incident responsibilities. This course is appropriate for personnel assigned the responsibility to develop and implement base contingency plans.

The Hazardous Substances Incident Response Management Course (HSIRMC) instructs HS OSOT team leaders about specific equipment and personnel protection requirements. This course has been especially beneficial to fire chiefs and environmental coordinators establishing and actually leading HS OSOT teams. In this course, students get to train in a variety of equipment and determine what gear is best suited for their base.

The most important training available to the HS OSOT is site-specific drill. The NOSCDR and HS OSOT leader should exercise regularly their contingency plan and go through a series of "what if" scenarios with their team. The team should be clear about its duties for dressing, entry, instrument operation, the most likely chemicals to be encountered and decontamination procedures.

Each team member should be medically screened, physically fit and be able to think clearly in emergency situations. The scientific coordinator must be able to retrieve reference material quickly and accurately and provide concise advice to the NOSCDR. The command staff and base departments (e.g., security) should be exercised to know their actions in an incident. The public affairs office should also be prepared to respond to media inquiries regarding a spill.

Reference Materials/Assistance Organizations

Reference materials and assistance organizations can be used to determine physical properties of a given compound, provide toxicological information including potential routes of exposure, and provide insight concerning potential pathways for dispersion of the compound in the environment. □

Many reference documents are available for use by response teams. A few which may be useful are: NIOSH/OSHA *Occupational Health Guidelines for Chemical Hazards*, NFPA *Fire Protection Guide on Hazardous Materials*, DOT *Hazardous Materials Emergency Response Guidebook*, USCG *Chemical Hazard Response Information System CHRIS* (Volume 2), *Dangerous Properties of Industrial Materials* (SAX) and *The Merck Index*. The OPNAVINST 5090.1, Chapter 12 and Appendix I, provide HS release message format and reporting requirements.

Federal and private organizations are available to assist in response situations. Some of the available Navy organizations include the NAVFAC EFD Code 114s; NEESA; the Naval Environmental Health Center (NEHC); and a private organization, Chemical Transportation Emergency Center (CHEMTREC) at (800) 424-9300 which can provide information on over 3600 specific chemicals EPA's Oil and Hazardous Materials Technical Assistance Data System (OHM-TADS) lists details on more than 850 materials and is available through NEESA (805) 982-4504 or A/V 360-4504.

Recoilless gun gives Navy new underwater capability

By JERRY THOMAS

A recoilless gun, using a high-pressure water jet instead of an exhaust gas thrust, is the key to a new anchor being developed by the Navy for installation in shallow waters, from the surf zone to 50 feet.

The Naval Civil Engineering Laboratory (NCEL), Port Hueneme, Calif., has taken a hybrid approach in its design of the Recoilless Propellant Embedded Anchor (RPEA) to give the Navy an operating capacity not available with present anchoring systems.

Basically, propellant embedded anchors are designed for deep-water installation. They must operate in water deep enough to allow gun recoil to be reduced by water drag. Consequently, the anchors don't function in water shallower than 20-50 feet, depending upon anchor size.

A world leader in anchor technology for 20 years, NCEL's latest technological concept relies on water, not gas, to stabilize the simple, lightweight anchor launcher.

In his design, NCEL Project Leader Dan True has incorporated existing anchor technology with rocket motor and water jet technologies. Accordingly, propellant gasses pressurize a water-filled container. They then shoot the water out of a recoil nozzle to the rear, creating the reaction needed to eliminate recoil.

By relying on water as the reaction agent, the new system requires only half as much propellant as its equivalent exhaust-gas version, making the RPEA lighter and more compact.

True has applied Newton's Third Law of Motion (equal action and reaction of a rocket) to develop the powerful water-jet gun that will replace conventional propellant gasses. This law of science is evident in a variety of applications, from a simple toy rocket to a sophisticated military recoilless gun. A typical toy rocket contains water and air under pressure. The rocket thrusts the water downward out of a nozzle and accelerates upward to heights of 50 to 100 feet. A conventional recoilless gun shoots a major portion of propellant gasses to the rear, creating a reaction to lessen recoil.

True got the idea to eject water under powerful pressure three years ago when he learned of a gun that relies on a frangible mass being expelled to the rear to react against recoil. He realized that water would be simpler and more effective to manipulate and control.

NCEL is testing conceptual models in its Deep Ocean Laboratory. Under the supervision of Senior Hydrospace Technician Carl Hilton, the tests are designed to evaluate the physical operations of reaction mechanisms.

Part of the Laboratory's preliminary investigations of propulsion concepts, the tests focused on a water-jet rocket motor model energized by high-pressure inert gas. Although pressurized gas water-jet motors are larger and heavier than pyrochemical propellant/water jet motors, the water-jet propulsion can be studied more economically by using the gas motor.

True said the gas and water were contained in a cylinder separated by a floating piston. A quick-acting nozzle valve on the water end was opened, allowing the water to exit at high velocity through the nozzle. The entire assembly was mounted on a stationary test platform to measure load, pressure, and acceleration during "firing."

Test results agreed with theoretical predictions and verified the functional reliability of the quick-acting nozzle valve. The concept, shown viable in demonstrations,

Basic class graduates 36 new CEC officers

The ranks of the U.S. Navy's Civil Engineer Corps swelled by 36 new members on June 7, 1985, when they graduated from the Naval School, Civil Engineer Corps Officers, Port Hueneme, Calif. All have accepted assignments in various locations around the world — at home and abroad.

The members of Class No. 175 completed eight weeks of specialized training pertinent to the school's needs for shore installation engineering, public works management, and Seabee operations.

Six class members finished with honors: Ensign Kenneth W. Branch was the oustanding graduate. Graduating with distinction were Lt. Robert B. Garlinghouse; Lt. Donald A. Plows; CWO2 Earl D. Ramsey; Ens. Eduard Gonzales; and Ens. Linda M. Thomas.

Ens. Kenneth W. Branch's photograph is indicated by (★). Those graduating with distinction are indicated by (•), and those entering Seabee duty by (†).

*†Ens. Kenneth W. Branch
BSCE/Univ. of Maine
to Gulfport, Miss.

Ens. Robert E. Andres
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Continued on next page

may be adapted to small anchors where a minimum weight system is not needed but where simplicity and freedom from pyrochemical handling precautions are significant advantages.

True said that 20K (20,000 pounds holding capacity) experimental models will be built in 1988 and 300K models in 1990.

Although primary development centers on a shallow-water system, the Navy expects the RPEAs ultimate capabilities to extend to all depths, in any sea floor material, plus installation on dry land.

The Navy is developing this new anchor technology to provide RPEA systems which are easy to handle and operate (50 percent lighter than present anchors), quickly installed, expendable, and capable of sustaining load in any direction up to 300,000 pounds. The NCEL version will eliminate operational problems currently associated with other anchoring systems. It will enable the Navy to install and operate many types of facilities presently beyond its capabilities.

Propellant embedded anchors were developed approximately 20 years ago to support salvage operations and moorings in coral seafloors. They also have proven effective in sand and mud seafloors where semi-rigid moorings must be placed accurately.

True said RPEAs could be designed to rest free-standing on the seafloor or on the beach, to remain stable in heavy surf, and to be fired through an electrical cable running to the operator's console on the placement support work boat or adjacent beach area.

Capable of installation in the surf zone, the RPEA system affords the Navy an added mode of service and operation. It also can be used for fleet operational facilities and construction support. □

Research civil engineer and project leader, Dan True (left), and Carl Hilton, senior hydrospace technician, prepare another in a series of tests of a recoil propulsion concept model in NCELs Deep Ocean Laboratory.

Authors: got the urge to write?

The magazine depends entirely upon contributions — YOUR contributions. If you're a member of the Civil Engineer Corps, Seabees, or an employee of NAVFAC, and you have information you want to share with other readers, please send it in.

Your subject matter should tell of problems and pitfalls they might avoid; tell of new programs and future plans; be significant technical developments or break-throughs; changes in procedures, systems, or methods; or new management concepts. Occasionally, we like a historical feature or a personal experience, but it must be unusual and interesting.

Worried about your ability to write? Don't be! Follow these simple directions and leave the rest to our editors. Your article must be no longer than 6 to 8 pages long, and must be exclusive to the magazine. Don't send copyrighted material.

HOW TO PREPARE

Type and double space all text. Not all capital letters, please! Include a title. It may be changed later; but it gives us an idea of what the article is all about. Define unusual terms. Dates should be civilian style — not military. May 4, 1986 — not 4 May 1986. Times should also be civilian.

Include your name, rank, position and if you are a registered engineer or architect, please indicate which state. Keep your sentences short. Don't use a big word when a smaller one will work.

ARTWORK/PHOTOS NEEDED

Illustrate your material with effective graphics — good, clear photos, line drawings or cartoon art. Photos should be black and white glossies, preferably 5″x7″ or 8″x10″. Color prints and negatives are not acceptable.

Photos should show action or something pertinent. No hackneyed grip 'n' grinners (handshakes), group shots, poses behind the important desk and nameplate, or other obvious poses please! Write a caption for each photo.

DON'T FORGET A RELEASE

You need a proper release. Request release form "Publication Security Review and Clearance" form NAVFAC 5720/6 from your local representative of the Regional Correspondence System or Public Affairs Officer, and include it with your article.

DEADLINES

The magazine is published four times per year with specific themes for some issues (see chart).

If you have questions, please call Autovon 360-3104, FTS-3104, or Commercial (805) 982-3104 and let's talk about your article plans.

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FALL 1986	Seabees	July 15, 1986	Oct. 1-15, 1986
WINTER 1987	Public Works	Oct. 15, 1986	Jan. 2-15, 1987

*General informational articles are acceptable for all issues including those with a suggested theme.

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BSCE/Purdue Univ.
to Adak, Alaska

Continued on next page

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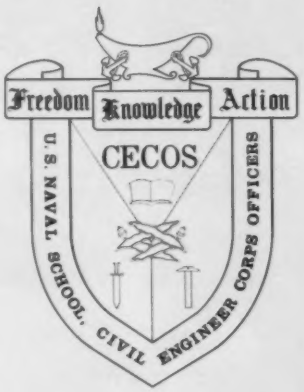

Hazardous waste:

One of the hottest issues of this decade

By LT. MICHAEL BLOUNT, CEC, USN
P. E., Calif.
NEESA, Port Hueneme, Calif.

Hazardous waste is one of the hottest issues of this decade. Newspapers and magazines report regularly about hazardous waste problems. Reacting to this, Congress has been busy passing hazardous waste-related laws and amending the existing laws. This is done with such regularity that it's difficult to keep abreast of the latest changes. Just when the regulations become understandable, the Environmental Protection Agency makes new changes (by order of Congress).

In order to store, treat or handle hazardous waste, it is necessary to keep up to date on the latest hazardous waste regulations — Federal, state and local. Regulatory inspectors will not accept ignorance as an excuse. Regulations must be turned into a sound hazardous waste management program that is dynamic and able to change as the regulations change.

The two most important parts of a sound hazardous waste (HW) management program are an up-to-date inventory and a management plan.

An updated HW inventory provides activity personnel with a snapshot of the variety, quantity, hazard and location of all HW located on the base. It is used to monitor the generators of HW; detect changes in generation trends; update management and operational procedures; identify requirements in HW handling, storage, transfer and spill cleanup; and provides the data for filling special and annual HW reports.

An HW management plan provides activity personnel with all the operational and procedural requirements needed to comply with pertinent regulations. It is used to:

- assign responsibilities
- define the HW management organization
- define and specify HW generation, containerization, collection, labeling, marking, packaging, storage, treatment, transfer and disposal operational procedures
- define the inspection requirements and procedures
- define the training requirements and procedures
- define the HW analysis procedures
- define or reference the HW spill contingency procedures
- define or reference one, or many, closure plans associated with the operation, and
- provide other important information pertaining to HW management

INVENTORY

To properly assess the degree of hazardous waste management required at an activity, an HW inventory must first be developed and maintained. This inventory should include all wastes generated on the base that have been designated as hazardous by Federal regulations (the Environmental Protection Agency's list of hazardous waste is found in part 261, title 40 of the Code of Federal Regulations, known commonly as 40 CFR 261).

There are three steps in the creation of an HW inventory. The first step is

deciding what type of data is required, the second step is the collection of the data, and the third step is organizing the data into a format that is easy to read and understand. Each step is described below:

Step 1: Data Required

As a minimum, the HW inventory should contain the following data:

a. The name of the unit, dept. or command responsible for generating the waste.
b. A description of the waste generated (EPA and DOT identification numbers, if possible).
c. The known hazard of the HW. Is it toxic, corrosive, reactive and/or ignitable?
d. The quantity of HW generated monthly.
e. The location where the HW is generated.
f. Type of accumulation or storage container. Is it a drum, underground tank, aboveground tank or other type of container?
g. The average quantity stored at one time.
h. The average storage time.
i. The current removal/disposal practices.

Step 2: Data Collection Procedures

There are four common methods used to collect data for HW inventories, which are:

a. **Activity-wide questionnaire:** A properly worded questionnaire can provide all the information necessary to build a complete HW inventory. The questionnaire, at a minimum should request the data items listed in Step 1.

b. **Site Visit:** A site visit inventory is done by personally investigating every work center. The investigator should inspect all accumulation areas, review all processes involving chemicals and interview workers.

c. **Examination of Incoming Hazardous Material Inventories:** All hazardous waste originates from hazardous materials (new chemicals) which are used in processes on the base. Contact the Supply Dept. for a list of ordered/delivered hazardous materials. Hazardous material's National Stock Numbers are usually coded to indicate that they are hazardous. Therefore, they can be extracted easily. When the hazardous material list has been developed, it can be used as a valuable clue to determine the type of HW generated. Every hazardous material has the possibility of becoming an HW.

d. **Examination of old Hazardous Waste Annual Reports:** Examining old Environmental Protection Agency (EPA) state or Navy annual reports can provide valuable inventory and generation information.

The above data collection methods may be used separately or in combination. It is good management practice to use at least two of the methods. Use one method for primary data collection and use another to verify the data collected.

Step 3: Data Format

Once the data required is known and collected, the last step is to present it in a manner that is easy to read and understand. The best way to organize an HW inventory is to develop a table. The following is an example of an HW table format. Another way is to present the inventory in a microcomputer program.

MANAGEMENT PLAN

The Hazardous Waste Management Plan (HWMP) provides activity-wide guidance to base personnel who work with HW. With the frequent personnel and regulation changes in activity experiences, the HWMP provides the consistent guidance necessary to support compliance with the regulatory demands.

The best way to develop an HWMP is to divide the plan into chapters, with each chapter addressing specific aspects and requirements of the hazard-

SAMPLE HAZARDOUS WASTE INVENTORY

(To show format only)

Responsible Tenant/ Command	Description of Hazardous Waste	Hazard (1)	Quantity Generated Annually	Location	Type of Code (3)	Quantity Stored	Average Time	Current Removal Practices
VF-98	Freon	T	220 gal	Bldg 1459	C	55 gal	Qtr	PW Pickup
	1,1,1 TCE	T	60 gal	Bldg 1459	C	20 gal	Qtr	PW Pickup
	Toluene	T	60 gal	Bldg 1459	C	20 gal	Qtr	PW Pickup
	Xylene	T	110 gal	Bldg 1459	C	5 gal	Mon	PW Pickup
	Naptha	I	60 gal	Bldg 1459	C	10 gal	2 Mon	PW Pickup
	Waste paint	T	110 gal	Bldg 1459	C	10 gal	Qtr	PW Pickup

(1) T — EP Toxicity
C — Corrosivity
R — Reactivity
I — Ignitability
M — Mixture

(3) C — Containers
UT — Under Ground Tanks
AT — Above Ground Tanks
O — Other (Explain)

ous waste management program. This will allow quick reference and facilitate revisions.

Typical HWMP chapters are listed and defined below:

1. **HWMP Implementing Base Instruction:** Implement the HWMP with an activity-wide instruction signed by the base CO. Make this instruction the first page of the HWMP.
2. **Introduction:** The HWMP begins with a section explaining to the reader the purpose of the plan and by what authority it was developed.
3. **Definitions:** To assist the reader in fully understanding the HWMP and other HW management documents, the EPA definitions of all major HW terms should be given.
4. **Regulations:** The major Federal, state and local regulations affecting an activity should be summarized in this component, with a copy of the regulations attached as an appendix.
5. **Responsibility:** The duties and responsibilities of all personnel involved with the HW management program are to be listed in this component.
6. **Organizational Chart:** A chart showing the HW management chain-of-command.
7. **Hazardous Waste Inventory:** See above section.
8. **Location Map:** A location map clearly showing the base perimeter and all areas where HW is generated and accumulated.
9. **Standard Operating Procedures:** Explain in detail the correct procedures concerning the generation, containerization, collection, labeling, marking, recordkeeping, packaging, handling, storage, treatment, transportation and disposal of HW. ***This is the most critical section in the HWMP!***
10. **Inspection Plan:** A well organized inspection plan is required to insure that the HW management program is being implemented correctly and the activity is complying with all pertinent regulations. This component may be a requirement by regulation.
11. **Training Plan:** HW management personnel are required to be trained so they can successfully complete their duties. In most cases, this component will be required by regulation.
12. **Spill Contingency Plan:** This section must describe the actions activity personnel will take to respond to a spill of HW. This is a requirement for all Navy bases and will most likely be a separate document. If it is a separate document, the HWMP should reference it in this section.

NOTE: The following documents are very specific plans required for activities with an EPA permitted Treatment, Storage or Disposal (TSD) facility. The requirements for each of these plans are mandated by the EPA (TSD regulations are found in 40 CFR 264) and each plan must be approved by the EPA prior to issuing a permit for a facility. These plans are specific to the TSD facility and usually do not affect the rest of the base.

13. **Hazardous Waste Analysis Plan**
14. **HW Facility Inspection Plan**
15. **HW Facility Contingency Plan**
16. **HW Facility Closure Plan**
17. **HW Facility Post-Closure Plan**

An HWMP should be a dynamic document, always adjusting to changes in an activity's mission and size. Additionally, as the regulations which mandate the HW management program change, the HWMP must be revised to incorporate these changes.

The Naval Energy and Environmental Support Activity has recently developed a guide to assist in the development of an HW inventory and an HWMP. It is titled "Hazardous Waste Management Planning Guide, NEESA N20.2-029A" and was distributed to all major naval activities. For information regarding this guide contact your EFD, Code 114. □

U.S. POSTAL SERVICE

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/s/ LES HELSDON, Editor

Low frequency program nears completion

By JAMES V. ROOT
R. A., N. J.
Project Manager, NORTHDIV

Recognizing the need for submarines to maneuver undetected at full speed while communicating with shore-based commands, the Navy embarked on the ambitious (ELF) Extremely Low Frequency communications program in the 1960s. After several name changes (Deepwell, Sanguine) and years of research and development, design and execution, the program is now nearing fruition. Northern Division, Naval Facilities Engineering Command executes the facilities portion of the program.

Unlike current communications systems that can penetrate only a limited range of seawater, ELF will provide the capability for transmitting messages to submarines operating at great depths and high speeds. This capability will provide an added measure of survivability to our nation's strategically deployed submarine deterrent forces.

The ELF communication system employs a number of overhead antenna elements installed in Northern Wisconsin and the Upper Peninsula of Michigan — areas of low underlying earth conductivity. Each antenna element consists of a long pole-mounted horizontal conductor powered by a transmitter. The current in the antenna penetrates the earth at the ends where the cable is grounded and excites electromagnetic waves in the earth-ionosphere cavity. These ELF electromagnetic waves travel through the atmosphere and penetrate seawater with minimal energy loss; they can therefore be received by submarines operating at depths where survivability is greatest.

The Wisconsin Transmitter Facility (WTF) located near Clam Lake, Wisconsin, was constructed in 1968 to test the ELF concept and the various components needed to make it work. Experiments conducted there proved the viability of ELF and provided the framework for implementing the program.

To provide greater range and reliability for the system, the Michigan Transmitter Facility (MTF) located near Republic, Michigan, was eventually programmed as an FY84 Military Construction Project.

The entire program is managed by the Space and Naval Warfare Systems Command, SPAWARSYSCOM, and has many participants. The Naval Telecommunications Command, NAVTELCOM, which will eventually operate the facilities, and the Naval Underwater System Center, NUSC, which is the proponent for the submarines, provide user input. General Telephone and Electronics (GTE) is the prime systems contractor supplying the communications equipment.

Northern Division has considerable responsibility in the successful implementation of the program. The WTF was originally constructed for ELF research and development and required upgrading to operate fully as a transmitter facility.

Two recently-completed projects totaling nearly $3 million include building renovation, additions and reconfiguration of the antenna grounds in support of the upgrade. By separate contract, a new fiber-optics telephone cable, which will dramatically improve the facility capability and reliability, is being installed to service the site.

The MTF, also under construction, is a $7 million project that includes 56 miles of overhead antenna configured in a large "F" winding through the Copper Country and Escanaba River State Forests in Michigan. Designed by Gilbert / Commonwealth, Engineers and Consultants of Jackson, Michigan, this project required extensive coordination with the Michigan Forest Service, Department of Natural Resources, private landowners, and the Army Corps of Engineers simply to secure right-of-way easements for the antenna.

Public opposition to the project, based upon concerns about its impact on the environment, led to a nine-month U.S. District Court injunction on construction which was lifted in June 1984.

The MTF construction contract was awarded in September 1984 and is administered by the ROICC, Great Lakes. Work on the antenna is nearly complete. It required cutting, clearing and grubbing a 50-mile, 100-foot wide right-of-way, setting antenna poles and stringing the 1-inch-diameter aluminum conductor. Work on the transmitter facility complex is underway with completion scheduled for January 1986. A follow-on contract to environmentally restore the land under the antenna will start in April 1986.

Facility design, construction and real estate acquisition, however, are not the only concerns at NORTHDIV. One drawback of the ELF system is its tendency to induce voltage on nearby telephone and power systems unless the effects are mitigated by appropriate design techniques.

ELF-induced interference to telephone systems can cause false bell ringing and static at customer locations and could cause electrical safety problems on power utilities due to excessive induced line-to-ground potentials. These undesirable effects can be controlled by altering the system configuration.

The IIT Research Institute (IITRI), on behalf of SPAWARSYSCOM, is responsible for planning and testing mitigation techniques. These techniques, such as conversion to multi-phase operation, neutral isolation and grounding reduce the voltages that the ELF in-duces on the systems to safe operating thresholds.

The manner in which these are used varies, however, depending on the configuration of the existing utility system and must be designed, pole-by-pole, by each utility company onto their affected plant.

With NAVFAC approval, NORTHDIV contracted with the four utility companies in Michigan that will be affected by the ELF interference to use the information provided by IITRI in designing mitigation onto their systems. The situation is unique because NORTHDIV is requesting, in effect, that the utility companies change their existing systems to a nonstandard op-

eration. This requirement causes considerable concern on the utility's part.

The utility's concerns stem from several issues. First of all, because ELF interference mitigation is relatively new, they must have confidence in the preliminary design information supplied by IITRI. Are the projected voltages accurate? Will the mitigation techniques work? Also, they are reluctant to enter into any contract for the benefit of the Navy in which they stand a chance of losing money. They want no profit from the work and accordingly wish to assume no monetary risk. The third major issue is that of future liability. Who is responsible if, after all mitigation is in place, someone is injured by ELF-induced voltages on their system?

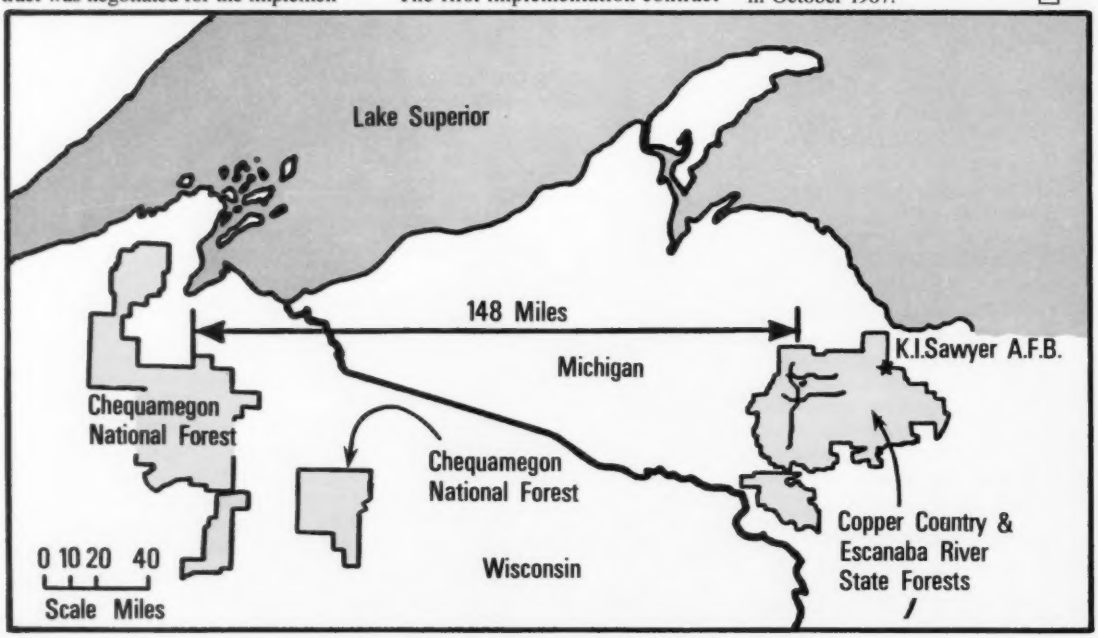
Resolution of these issues required unique contractural arrangements. The utility companies eventually agreed, after considerable negotiations over standard terms and conditions, to enter into firm fixed-price A/E contracts to accomplish the design work. The specific scopes of work had to be very detailed, however, to allow additional compensation for any altered design parameters developed by IITRI.

A cost-reimbursement service contract was negotiated for the implementation phase wherein the utilities would be compensated on Government-audited costs incurred for labor and material. Citing the unusual liability risk assumed due to ELF operation, NORTHDIV requested indemnification for the utility to make the Navy, in effect, responsible for ELF-related lawsuits over and above their normal insurance protection.

The first implementation contract was awarded to Michigan Bell Telephone in September 1985 and mitigation for all remaining utilities is scheduled for completion in September 1986, when operational testing will begin.

With all facility construction completed, GTE equipment installed and interference mitigation tested, SPAWAR will transfer operation of both the WTF and MTF to NAVTELCOM in October 1987. □

Work proceeds on the transmitter building at the Michigan Facility. The Transmitter Complex includes a power distribution building, dummy load building, and gate house.



ELF antenna and transmitter locations

The transmitting portion of the Extremely Low Frequency (ELF) communications system will consist of two transmitting facilities: one in Northern Wisconsin, the other in the Upper Peninsula of Michigan

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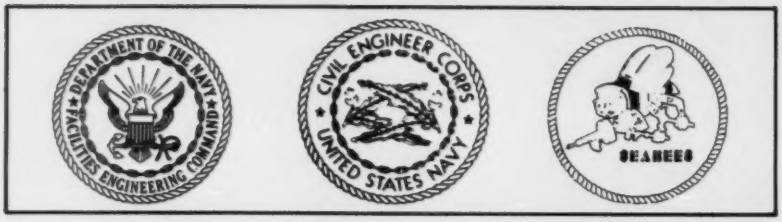

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Personal Comments or Recommendations _____

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(Signature is optional)

Have you considered the Reserves?

For a challenging, rewarding career . . .

If you are a young construction professional in civilian practice or civil service, or are a graduating engineering or architecture college senior who has already selected a civilian career path, the Reserve CEC may have a place for you as a commissioned officer.

Qualified young professionals have the chance to achieve tremendous personal and professional satisfaction through . . .

- Direct appointment as an ensign, Civil Engineer Corps, United States Naval Reserve
- Challenging assignments within Reserve Naval Construction Force units in your geographic locale, in areas paralleling active CEC duty in the Seabees or in facilities' management
- Annual active duty for training that is meaningful and rewarding
- Development of leadership and technical skills that will carry over directly into your civilian profession
- New and lasting friendships and associations with other top-notch construction professionals
- Pay and responsibility that increases as you grow and advance
- A Naval Reserve retirement package for a little something extra in your old age
- Finally, and most importantly, the pride in knowing that you are helping preserve the freedom of your country as you grow in your profession

Here's what you can do . . .

If you are a young engineer or architect, male or female, please call the Reserve Representative listed below.

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Eastern Region, RNCF
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Philadelphia, PA 19112
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Or, contact an Active Duty EFD Accessions Officer listed on the inside front cover for further information and details . . .

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